POWER

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The Spotlight Engineer

By Rufus T. Strohm

SOME years ago Philander Potts was taken with the whim
That posing in the limelight would be flattering to him;
And so he donned his overalls and set to work with zest
To make his power plant surpass the city's very best.
He looked for signs of glaring waste, he hunted hidden leaks,
And thus he probed and nosed around for many weary weeks,
And when he found a shaky spot, he fixed it up for good,
Till finally he made the place run somewhat as it should.

By dint of ceaseless tinkering, it followed that in time
The state of his equipment rose from middling up to prime,
And thereupon he ran some tests, whose figures plainly showed
A marvelous efficiency at near the normal load;
And these — Philander took good care — were glaringly displayed,
To advertise to all the world the record he had made,
And engineers arrived in droves from distant parts to see
Philander's plant and shake the hand of such a man as he.

The engineering papers published pictures of the place,
And incidentally they showed our hero's smiling face,
For when the staff photographers performed their little stunt,
Philander somehow managed to be posing right in front.
And thus for many months he held the center of the stage —
Apostle of Efficiency and Engineering Sage.
But after while the fickle world lost interest in him,
And then Philander's star became a wan and sickly glim.

He found that mischief-making Fate had played a shabby trick,
Because the record he had reached could not be made to stick
Unless he kept his weather eye forever keenly peeled
To note development of leaks and have them promptly sealed;
Now, patient plodding was a thing Philander would detest,
And so he let his duties slide and took a lengthy rest.
Efficiencies went tumbling down, the pretty bubble burst,
And verily, the final stage was lower than the first.

* * * *

The biggest dub in seven states can patch things up a bit
And run a seven-hour test to show that he is IT;
But if you want your shekels saved, select for engineer
The sort of guy that's on the job each minute of the year.

The Heating Plant as a Source of Power

By IRA N. EVANS

STEAM used for heating is a source of power often wasted in large heating installations although the greater part of the equipment is operated and fuel provided seven to eight months of the year. Large savings may be effected by recovering the power in the steam and utilizing the exhaust for heating. In all heating problems the possiblity is present and is commercially profitable so long as the plant is of sufficient size to warrant the additional investment in equipment required. In the case of a new development no additional expense is involved beyond the necessary standard generating equipment. The rapid increase in the the cost of fuel and labor and the scarcity of coal should cause a revival of interest in this method of conserving coal.

In heating plants of five hundred horsepower and over large savings may be effected by operating at high pressure and recovering the power from the steam before it is passed on to the heating system. The power equipment proposed is a turbo-generator unit condensing into the heaters of a hot-water forced circulation system. The vacuum is varied arbitrarily to meet changes in outside temperature from atmospheric pressure to twenty-eight inches of vacuum. With this range of vacuum the water rate of any turbine will vary one hundred per cent, and owing to this fact the steam exhausted will practically balance the varying heating requirements, a constant electrical load may be recovered throughout the heating season, and in summer the power unit may be operated condensing.

In the past it was symbolical to picture a busy and prosperous factory with clouds of steam and great volumes of black smoke issuing from the chimneys. It is no longer so, as these symbols are absolute and never-failing evidences of waste in power development and imperfect combustion. Still there are engineers who, although knowing these facts, recommend heating by live steam and purchasing power. There may be some excuse for the small plant, but the larger installations have none to offer.

If this power that it is possible to recover from the heating fuel were purchased, although manufactured perhaps on a large scale for less cost, whatever labor, fuel or equipment was required would involve just so much duplication and waste as far as the community is concerned. The heating plant would have to be operated in any case, with all stand-by losses, labor, etc. There is, however, one necessary requirement for economy. Although the use of exhaust steam will always show a saving, its waste to the atmosphere at any time may nullify any previous saving for the combined operation.

Some simple experiments with a teakettle and thermometer on a gas range will demonstrate how much of the heat in the steam is available for heating and show its relation to that used for power. The accuracy will depend somewhat on the constant pressure and rate of flow of the gas, but the results will suffice for the purpose. Place a given amount of water in a teakettle and with the gas jet set the same throughout, raise the temperature of the water to 100 deg. Notice the time it takes to raise it from that temperature to the boiling point. Then notice the time required to boil the kettle dry. It takes, say, 5 minutes to raise the water from 100 deg. to 212 deg. and 43.5 minutes to boil the kettle dry, or nearly 8½ times as long. If the vessel were closed and of sufficient strength, 5 minutes more, after the water began to boil, would suffice to bring the pressure up to 200 lb. The tests show approximately the relations between the heat required to generate steam for heating and for power. From 10 to 20 per cent of the heat in the steam is available for mechanical work depending upon whether the plant exhausts to atmosphere or is operated condensing. The other 80 to 90 per cent is known as latent heat and is always a complete loss when only power is generated.

The open teakettle corresponds to the boiler of the steam-heating system, a large pipe leading the steam

FIG. 1. REASONS WHEN EXHAUST STEAM HEATING DOES NOT PAY

FIG. 2. AN INVESTMENT OF GENERATING EQUIPMENT COULD SAVE $65,000 PER YEAR

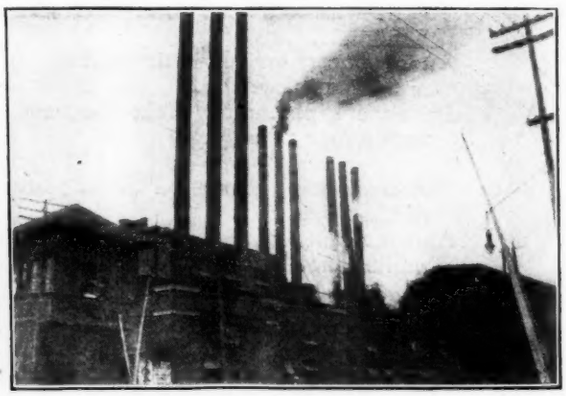


FIG. 3. THIS WASTE CAN BE SEEN NEARLY EVERY DAY IN THE YEAR. ALL CURRENT IS PURCHASED

to the different fixtures such as radiators and fan heating coils if hot-air heating is employed. A small pipe leads back to the boiler plant to return the water as the steam condenses.

This type of system is handicapped by the distance the steam may be transmitted, as a drop in pressure is required to overcome friction of the piping, and all pressure above atmosphere reduces the engine economy

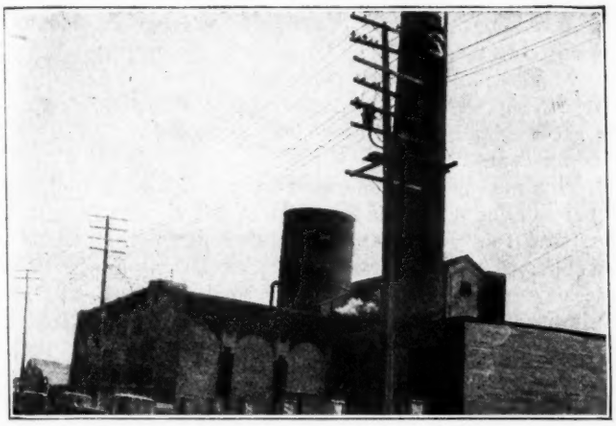


FIG. 4. COMBINATION POWER AND HEATING PLANT WITH COOLING TOWER, RECOVERING $27,000 WORTH OF CURRENT PER YEAR FROM HEATING STEAM

if exhaust steam is used. Besides grades must be given careful consideration in order to cause the condensation to flow.

On the other hand a hot-water system with forced circulation may be used for heating. Heaters or condensers transfer the heat of the steam at any pressure and temperature to the circulated water. Mechanically operated pumps are used to circulate the water through the same type of fixtures and radiators as are employed in the steam system. Supply and return pipes are of the same size, although both are much smaller than required for the steam system. The circulation is under control and will be the same whether the water is hot or cold. Grades and distance are negligible factors. Since the entire system is full of water, all that is required of the pumps is to overcome the frictional resistance of the pipes, the pressure due to the height of the system being the same on both sides of the pump.

The temperature of the circulating water may be varied from that of the steam system, say 220 deg., down to 100 deg., offering a wide range to compensate for outside weather changes and making it possible to operate the power end of the plant on a vacuum. The steam system, on the other hand, operates of necessity on nearly a constant temperature and regulation is obtained by shutting off units either by hand or automatically.

From the previous discussion it may be seen that a steam-heating system demands power generation on a non-condensing basis as against possible condensing operation with forced hot-water heating. Increase in distance and load affect the steam system of distribution by raising the initial pressure required for circulation and consequently increasing the back pressure on the engine. The result is a higher water rate and reduced power capacity. With a forced hot-water system the circulation is independent of the temperature of the medium.

In every large manufacturing plant using current and maintaining boilers for heating, theoretically 10 per cent more coal will make the steam available for power purposes. In this way the power may be recovered from the steam used for heating, latent heat being dissipated by the heating system and every heat unit utilized. The only precaution necessary for exhaust-steam heating to be economically successful, is that power generation be not continuous on a non-condensing basis. When not needed for heating, this same latent heat becomes a debit, if power is generated uneconomically, and the winter's savings may be dissipated during the summer. It is the correlation of functions for both power and heating on which exhaust-steam heating depends for ultimate economy.

It is entirely feasible to arrange equipment so as to produce a nearly constant power load recovery, utilize the latent heat in the heating system and yet generate the power load in summer at a low water rate, when heating is unnecessary.

What better condenser could be furnished than a hot-water heating system, as it is nothing more than a dissipator of heat with variable requirements due to the weather. Lack of a pond or river for cooling water in summer is no handicap, as a cooling tower may be used. The latter depends upon the mechanical evaporation of water by blowing large volumes of air through a fine spray. A roof or vacant lot will serve the purpose, and no more than 1½ lb. of water is used per pound of steam condensed. However, a large volume of water is circulated over and over, the figure given representing the actual loss from evaporation and wastage. Strange as it may seem, the actual water loss is less with the cooling pond or tower than when the engines exhaust to the atmosphere.

FIG. 5. TURBO-GENERATOR AND FORCED HOT-WATER PLANT THAT FOR 8 YEARS HAS BEEN RECOVERING 400 KW. FROM HEATING STEAM

The conditions required for economically recovering power from heating fuel may be stated as follows:

1. Ample capacity for heating in the coldest weather.
2. Flexibility in capacity to meet outside weather changes, that is, a variable temperature of the heating medium.
3. Power load recovered should be nearly constant in amount regardless of the heating requirements; that is, variable steam rate for power.

4. Ability to shift at all times to the lowest steam rate for power, as the heating requirements change, without interruption of the power or heating functions.

The apparatus that will fulfill these requirements is a hot-water forced circulating system with the heaters used as condensers. If a constant amount of water is circulated, all that is necessary to regulate the room temperature is to vary the temperature of the water, and this may be done by varying the vacuum on the condenser to give the temperature desired.

For large plants the water system is somewhat cheaper to install, the variable temperature of the medium enables better regulation, and the steam may be used at pressures below atmosphere, thereby lowering the water rate of the generating unit. On the other hand, the steam system requires nearly a constant pressure, approximately atmospheric, and therefore the maximum steam power rate. The only way of varying the amount of steam for the system is by changing the power load.

To show the possibilities, the following data are presented to permit comparison. A kilowatt-hour is generated by the average central station on, say, 17 to 20 lb. of steam, all losses included, when operating under high vacuum.

On a non-condensing basis in the private plant the rate varies from 35 to 45 lb., with all losses included, the larger machine operating at the greater economy as before. This means a coal rate of from 2 lb. to 4.5 lb. per unit of power, dependent on whether the plant is operated condensing or non-condensing.

In most northern climates the heating season varies from 5,000 to 6,000 hr., dependent on the latitude. There are 2,500 to 3,000 hr. for power operation working one shift per day and 4,500 to 4,900 hr. for two shifts.

In most large plants the heating systems are operated continuously night and day throughout the season, with a general variation from 100 per cent capacity in extreme weather to 40 per cent as the minimum in moderate weather, the average being 65 to 70 per cent, dependent upon the flexibility of the system.

Public-service rates vary, depending upon the locality, the amount of current purchased and the relation of the maximum demand to the average load. The lowest net rate known to the author averages about one cent per kilowatt-hour. Although much lower than the average this figure will be used in the following computations.

If a manufacturer installs his own generating plant, double equipment has to be provided for breakdown service as, owing to the method of charging for this accommodation, the cost may be prohibitive.

There is no doubt that most public-service companies can equal or better the isolated plant in summer on a straight power-generating basis, particularly if the plant is operated non-condensing. The following case will show how exhaust-steam heating may prove uneconomical. Assume a plant requiring a maximum of 1,000 boiler-horsepower in zero weather for heating with the steam system on a non-condensing basis. Observing the figures given previously, the recovery in power for 3,000 hours, considering one shift only, would be as follows, with a constant noncondensing steam rate of 45 lb. per kilowatt-hour:

Recovery from maximum load $= 34{,}500 \div 45 = 766$ kw.; from average load, 65 per cent, $= 500$ kw.; from minimum load, 40 per cent, $= 300$ kw.

Unless exhaust steam is wasted to the atmosphere to balance the variable heating requirements, the power recovery will be far below the average and variable in amount. At the period of minimum load the engine would be operated at an uneconomical underload or steam would be wasted to the atmosphere.

If current beyond that supplied by the heating steam could be purchased from the public-service company for one cent per kilowatt-hour, so that no steam would be wasted to the atmosphere, the average load of 500 kw. could be recovered. Then the recovery would amount to $3{,}000 \times 500 = 1{,}500{,}000$ kw.-hr., which at 1c. would equal $15,000 per year. If the generating unit of, say, 800 kw. capacity cost $50 per kilowatt, the gross saving would be $15{,}000 \div 40{,}000 = 0.375 = 37.5$ per cent.

If this engine were operated in summer with fuel at $6 per ton and 4.5 lb. of fuel was required per kilowatt-hour, the fuel alone for unit power production would cost $600 \div 2{,}000 \times 4.5 = 1.35$c. This shows the necessity of the constant power load recovery and a minimum power rate when heating is not required. Otherwise the summer operation would nullify the winter saving. If this engine were exhausted into a low-pressure turbine on a condensing basis, no steam would be discharged to atmosphere, minimum water rates would be obtained in summer, and with a constant power load the whole gross saving of 37.5 per cent could be conserved. The public-service rates for current could be met in summer, but the investment would be excessive.

It is characteristic of the turbo-generator that its steam rate will vary 100 per cent between atmospheric pressure, or 212 deg., and 28 in. of vacuum, or 100 deg. With such a unit installed and the vacuum varied to meet the heating requirements, the heating and power steam will very nearly balance. Suppose 5,000 boiler horsepower is required for heating in zero weather, the maximum and minimum quantities will be as follows:

	0 Deg. Outside	75 Deg. Outside
Heating, hp.	5,000	2,000
Per cent load	100	40
Steam available for both power and heating, lb.	172,500	69,000
Temp. circulated water, deg. F.	210	100
Terminal exhaust pressure	3 lb.	28 in. vacuum
Steam rate, lb. per kw.-hr.	35	17
Power load, kw.	5,000	4,600

Notice there is the same variation in all these quantities, consequently they will balance for any intermediate point. It is evident that the power recovery will average in kilowatts about 90 per cent of the maximum boiler horsepower in zero weather.

Take a plant requiring 1,000 boiler horsepower in zero weather, operating one power shift, with a heating season of 5,000 hours. Then the average power recovery will amount to

$$0.9 \times 1{,}000 \times 5{,}000 \times 0.65 = 2{,}925{,}000 \textit{ kw.-hr.}$$

At 1c. per kw.-hr. the value of the recovered power is $29,250 per year. Assuming double equipment is required, with no public-service current, the investment for generating equipment would be 2,000 kw. $\times$ $50 = $100,000. Then the gross saving would amount to

$$29{,}250 \div 100{,}000 = 0.2925 = 29.25 \textit{ per cent}$$

There would be little additional labor or expense, as the boiler plant has to be maintained anyway and generally in summer. The cost of current in the summer season would be about the same as the public-service rate. Suppose that there was unlimited capacity for this

recovered current, that the public-service current was available for breakdown service and only one machine was required. Then the machine could be run at full capacity for the 5,000 hours and the value of the recovered current would be

$0.9 \times 1{,}000 \times 5{,}000 \times 1c. = \$45{,}000$ *per year*

The cost of one machine would be $50,000, so that the annual saving on the investment would amount to $45{,}000 \div 50{,}000 = 0.9 = 90$ per cent. Also notice that the power recovery in the previous example with a constant steam rate, is only 1,500,000 kw-hr. as against 2,700,000 kw.-hr. when operating under vacuum.

The additional investment needed for this method of power recovery from heating steam is warranted in all plants of 500 hp. capacity and over. Condensing equipment is necessary and where no natural source of cooling water is available, cooling towers or spray ponds are to be used. All equipment needed is standard, its performance well known, and there is no question about the results.

To estimate the possible saving, take 90 per cent of the boiler horsepower required in zero weather for heating and determine the period of time the current can be utilized. The product of these two figures will be the total kilowatt-hours that may be recovered, and multiplying by the prevailing cash rate for purchased current in the district will give gross saving for the year.

Overhauling a Diesel Engine

By G. H. Grow

Recently, I was called in to operate an old Diesel engine until a permanent engineer could be secured. The operator who had resigned had not kept the engine in the best of shape.

I found the valve setting on all the cylinders somewhat late. The fuel valves all opened after dead center. The helper said that the operator had set them late to avoid pounding of the crankpin bearings. Late injection helped no doubt, but as the pistons were all worn, the compression even at dead center was not over 400 lb. per sq.in. With the late timing, five degrees after dead center, the compression was not up to this value since the air was escaping down along the piston. Even though the piston had not started to move downward at the beginning of injection, the compression was so low that the engine smoked badly.

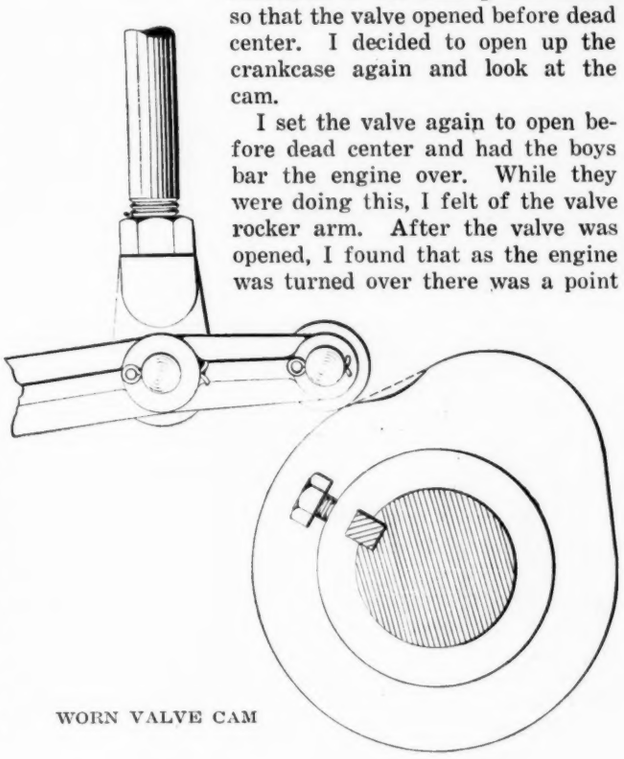
The fuel-valve push rods were adjusted to open the needle valve at five degrees ahead of dead center. The piston rings were removed and were found to be "set." Since no spare rings were at hand, the diameters of the old rings were increased by hammering the inside faces. This caused the rings to hug the cylinder walls more closely, lessening the leakage of air.

On examining the timing of the air-admission valves, all were found to open very late. I checked them up, making the opening point about fourteen degrees ahead of dead center. The cylinder-head joints had leaked slightly and the gaskets were burned in places. New copper gaskets could not be procured; as a makeshift several sheets of No. 22 gage galvanized sheet steel was purchased and gaskets made from these sheets. On tightening down the heads, these gaskets held without leakage. Such material is entirely too hard for general use, but will do as a makeshift.

After going over the engine, tightening up all bolts and making every bearing snug, the engine was started up. To my surprise, after getting one "kick" out of the starting cylinder, the air valve refused to open again. This was strange since no one had altered the length of the push rod. The crankcase doors were opened, whereupon it was discovered that the air starter rocker-arm roller had a flat on it. The roller had turned as the camshaft revolved, causing the flat to rest against the cam. As a result no movement of the starting-valve push rod took place. This was remedied by replacing the roller.

We set the engine in the starting position again and turned on the air. The engine turned over a few times and started firing. Everything seemed to be all right except one admission valve, which continued to chatter. We supposed the valve spring had set or was broken and stopped to replace it. After doing this and starting again, the valve continued its chattering. This was a puzzle to me until the helper said that it always chattered if the timing was made so that the valve opened before dead center. I decided to open up the crankcase again and look at the cam.

I set the valve again to open before dead center and had the boys bar the engine over. While they were doing this, I felt of the valve rocker arm. After the valve was opened, I found that as the engine was turned over there was a point



WORN VALVE CAM

at which the valve closed again and the rocker arms moved free. I found the cam was worn badly at one place.

When the valve was set to open early, the roller touched the cam ahead of this worn spot as is shown in the sketch. As the engine revolved, the roller met this worn place; since the cam surface was much below its true shape, the roller moved downward, allowing the valve to close again. The worn portion was of considerable length, and the valve remained closed until either the suction pressure or the rocker opened it again. Since the cam was traveling at a high rate at this time, the valve was kicked open with considerable force. The rocker arm rebounded and the valve chattered. Evidently, the engine had been set to open late for a long time, and the hammer blows of the roller as the cam struck it while moving at a high rate of speed wore the cam surface. It was impossible to obtain a new cam at once, so the valve was set late until a new cam arrived.

Testing Direct-Current Relays

Inspection of Relays Before Installation—Testing Relay Switches—Methods of Obtaining Load for Testing—How Tests Are Made on Various Types of Relays—Interpretation of Test Data

By VICTOR H. TODD
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NO MATTER how carefully a relay is constructed or tested, it is always well to remember that no piece of apparatus is infallible. For this reason all relays should be tested before being installed and should be subjected to periodic tests after installation. In well-equipped meter shops will be found adequate apparatus such as meters, loads and batteries for making simple or elaborate tests, as the case may be. This article will treat mainly of tests made on the relays while in service.

Practically every manufacturer gives complete directions for the installation of his particular type of relay, and these instructions, of course, should be carefully followed to obtain correct results. In general, they deal with mechanical features, such as seeing that the moving parts are free, that there is no dirt or packing material in the relay and that there are no loose screws or nuts or damaged parts. A diagram of connections also accompanies each relay, and this would always be used in the absence of another authoritative diagram, which might be used to include other instruments in the same circuit. A relay should always be mounted on a firm, solid support, such as a switchboard. It must be accessible for easy inspection and testing and never mounted in a place where it will be subjected to excesses in temperature, moisture, destructive fumes or stray fields. In case a relay must be installed in a dusty place—for instance, a flour or cement mill—it must never have exposed contacts; they must always be inclosed, preferably under a glass cover. If a cover does not accompany the relay, it should be inclosed in a glass-covered dustproof box.

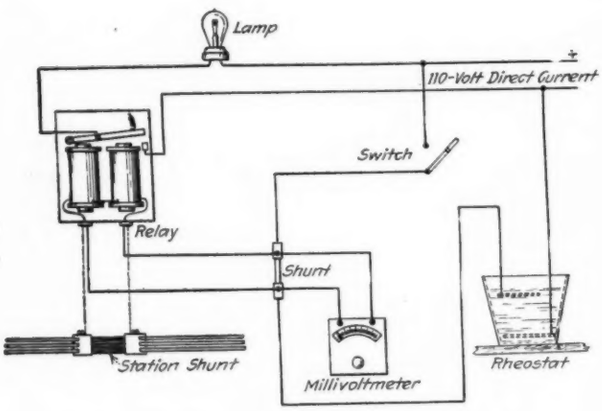


FIG. 1. TESTING CONNECTIONS FOR MILLIVOLT-TYPE RELAY

The circuit breakers and switches too, must receive periodic attention in order that they may not fail at a critical moment. In fact, manufacturers sometimes recommend that the whole protective combination of relays, relay switches and circuit breakers or automatic oil switches be used to open the circuit whenever it is necessary to open it, thereby insuring correct functioning of all units.

Before installing and before making a periodic test, the relay should be tested for "grounds." While this is really a test for live-metal-to-frame defects, it will readily detect defective spots in the insulation, which must be reinsulated against all possibility of breakdown in service.

Testing Relay Switches

The relay switch is perhaps the easiest piece of protective apparatus to test. First make sure that all screws and nuts are tight; that it is firmly mounted; no loose connections; and that the contacts are clean and bright and not burnt. If they are burnt or pitted, take a piece of fine emery cloth (never use crocus paper, it leaves a muddy deposit) and after doubling work it back and forth between the contacts, which should be held firmly against the emery. In this way grind the surfaces until they meet accurately. Then energize the solenoid, correct voltage and see that the plunger rises freely and quickly, and closes the contacts positively and firmly. If the trip circuit is operated from a storage battery, it is well to see that the plunger rises satisfactorily when the solenoid is energized on 70 per cent and 130 per cent of the normal voltage. This is to insure correct operation no matter how low or high the battery voltage may go. Failure to operate should be carefully investigated and the cause removed. It may be due to foreign substances, damaged parts or rubbing magnetic surfaces.

If a direct-current circuit is available and the relay to be tested is of the millivolt type, a portable lamp bank or a resistance box may be used, connected as in Fig. 1. If undesirable to trip the breaker in making the test, substitute a lamp as shown connected to the upper, or trip circuit, terminals.

The series types, such as the plunger relays are not so convenient to test, as the whole load must be passed through the series coil. If possible, this is done by building up the load until the breaker trips. This test can often be made at night when an occasional interruption does not interfere seriously with the service. If the load is not too large, water rheostats may be used. A large barrel, filled with water, with an electrode at the top and bottom will handle considerable load. The variation is obtained by continually adding salt, meanwhile watching the ammeter and noting the point at which the relay trips. As an illustration of how great a current may be controlled in this manner, a barrel three-feet deep with electrodes two feet square should handle 500 amperes easily at 100 volts. The variation may also be obtained by moving the electrodes closer together or farther apart.

Another way of obtaining a load is to immerse an iron-wire rheostat of the necessary resistance in running water. For smaller loads and where it is undesirable to interrupt the load, two or three cells of storage battery, such as used for meter testing, may be used with a water rheostat or a carbon rheostat.

Assume, for example, that a millivolt-type relay must trip when the load reaches 800 amperes, but it is impractical to get this load from the line. First disconnect the operating coil leads at the shunt and the trip leads at the relay. Give the usual mechanical inspection, clean the contacts and make a ground test. Note the capacity of the shunt; say it is 50 millivolts at 1,000 amperes; therefore, at 800 amperes it would give $\frac{800 \times 50}{1{,}000} = 40$ millivolts. Instead of saying that the relay must trip at 800 amperes, we can say that it must trip on 40 millivolts; then it simply becomes a problem to obtain 40 millivolts from an external source. Take a standard shunt giving 50 millivolts at 5 amperes and connect as in Fig. 1. Gradually increase the load until the millivoltmeter reads 40 millivolts and then adjust the relay so that it trips. Several trials may be necessary. Note that the current is unknown exactly, but that it takes approximately four amperes in the test shunt to produce exactly the same effect on the relay as 800 amperes in the station shunt. Then when the relay is reconnected to the station shunt, we know it will

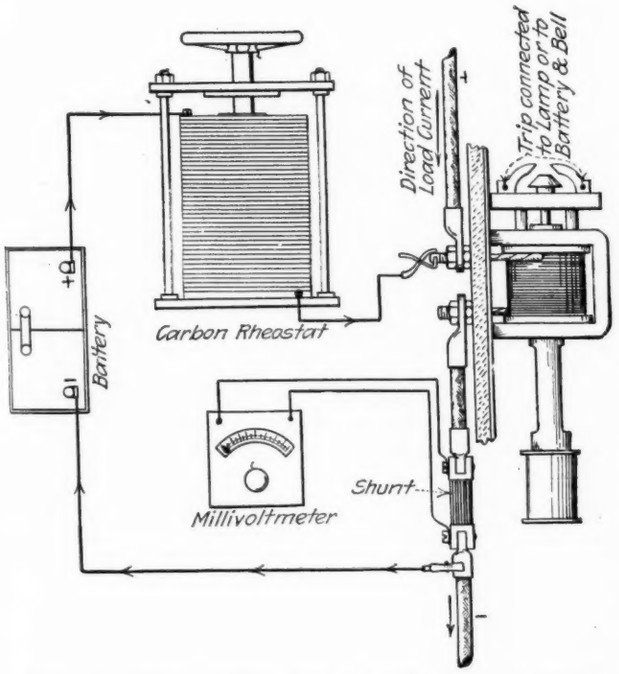


FIG. 2. CONNECTIONS FOR HEAVY-CURRENT TESTS

trip on 800 amperes although it was only tested with a four-ampere load.

When testing a plunger-type instantaneous trip relay, first give it a thorough mechanical inspection, carefully trying every nut and screw and looking for burnt coils and loose connections; clean the contacts and then make a ground test. If the current capacity is low, say below 25 amperes, it may be preferable to connect a jumper around the relay to completely short-circuit it and then disconnect the relay from the circuit, reconnecting it to the test load. If of a larger capacity, it is generally preferable to build up the load on the circuit itself if this can be done without interfering with the service. Otherwise, connect a storage battery and rheostat as shown in Fig. 2, being sure to include the station shunt in the battery circuit. This enables the main-load current to be used in addition to the test current; or if the load current is already too high for the lower set-

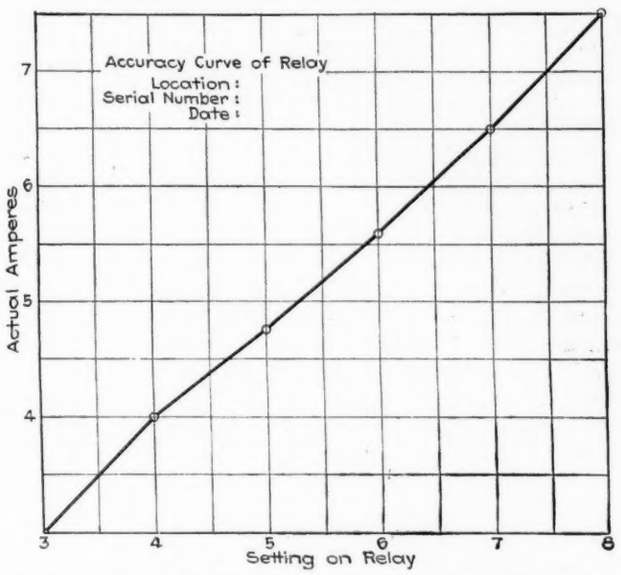


FIG. 3. CURVE SHOWING RELATION BETWEEN RELAY SETTINGS AND ACTUAL CURRENT

tings, reverse the battery and buck the load current, through the relay, down.

For instance, if a relay must trip on 600 amperes and the load current is only 500 amperes, then the battery must supply the extra 100 amperes. It is not necessary to measure these separately, but the station ammeter will read their sum.

After making all connections so the load, or overload, can be quickly applied, the time, required by a time-limit relay may be determined with a stop watch. First carefully set the rheostat to give the current value at which it is desired to take the time; disconnect and let the relay fully reset. Then quickly apply the load and start the watch, both at the same instant, press again to stop the watch when the contacts close. The watch hand indicates in fifths of a second the time required to close at that particular current. If impossible to apply the load quickly, quite close results can sometimes be obtained by building up the load and holding down the plunger by hand, releasing it and snapping the watch at the same instant. By varying the load and the time settings the time of the various combinations can be obtained.

Whenever relays are tested, the results of the test should be permanently recorded in curves or tables. On relays without time-delay elements, the actual amperes may be plotted against the setting as in Fig. 3. To do this, set the relay for the lowest setting, say 4 amperes; then slowly raise the current and note the reading of the ammeter just as the plunger rises. Assume that it takes 4 amperes. Make a dot where the 4-ampere horizontal and vertical lines intersect. Change the setting to 5; then it may take only 4.75 amperes, there-

fore, make a point where the 4.75 horizontal line intersects the 5 vertical. In the same way locate the currents required for 6, 7 and 8 amperes and draw a curve through them, as in the figure.

Now suppose a relay is set for 4 amperes and gives satisfactory service. Then, for some reason, it is desired to have the relay changed to 8 amperes. Before changing to the No. 8 setting, the operator would look up his curve and see that the relay trips at only 7.5 amperes at this setting. This might be satisfactory, or it may be necessary to readjust the relay to give 100 per cent accuracy at this point. In any case, the curve has saved the operator from depending on the relay to trip at 8 amperes only to have it trip at 7.5 amperes, perhaps throwing out the whole system without cause.

Time-limit relays require more elaborate curves and tables. It is generally best to plot the load on a certain setting against the time. This requires a separate curve for each setting although these are frequently made on the same sheet, as for instance in Fig. 4, which shows the curves for a time-limit relay of the dynamometer type. Curve A is made with 118 per cent of normal voltage on the field coil and the contact arm set to trip on a minimum of 2 millivolts. At 2 millivolts, it takes from 4 to 8 sec. to trip, this being a very indefinite point on the curve. With 5 millivolts applied to the same setting, it takes 1.4 seconds; 15 millivolts applied to this same setting takes only 0.5 second. With the setting changed to 5 millivolts minimum the time values are shown in curve *B*. The results when a 10-millivolt setting is used and the time of different applied millivolts taken, is given in curve *C*. Curve *B'* is made with the voltage lowered to 59 per cent of normal and the

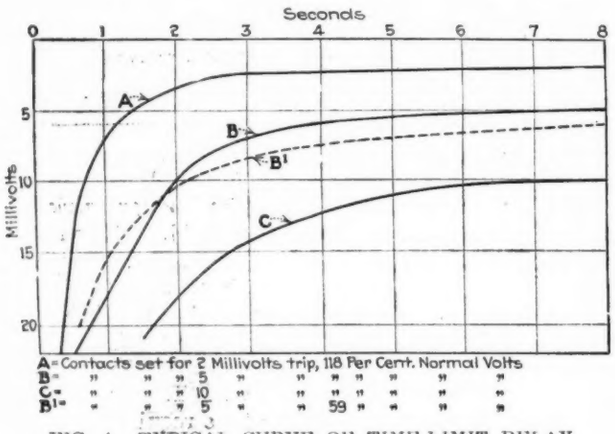


FIG. 4. TYPICAL CURVE OF TIME-LIMIT RELAY, DYNAMOMETER TYPE

contact arm set for 5 millivolts. The table Fig. 5 gives the same results in tabulated form.

Curves are generally to be preferred to tables when in intelligent hands, but there is less liability to error in using tables, and expert opinion is divided as to which is preferable.

In making a very accurate test, in which the trip circuit has been disconnected, time must be allowed for the closing of the relay switch and the opening of the breaker. In general this will be found to be 0.2 or 0.3 of a second, so when setting the relays for actual operation, it must be remembered that the breaker does not actually open until 0.2 or 0.3 second after the contacts close.

In setting time accurately, the type of relay must be considered and its limitations taken into account. This is especially true of the bellows and dashpot types. The bellows, unless carefully oiled every few months, will harden and the time of trippings cannot be depended upon at all. The dashpot relays will give greatly varying time due to a change in the viscosity of the oil if used where they are subjected to extremes in tempera-

Relay Service:	Location:			Date:
Voltage →	118 Per Cent. Normal			59 Per Cent. Normal
Millivolts Setting →	2	5	10	5
Applied Millivolts	Tripping Time in Seconds			
2	8.0			
5	1.4	8.0		
10	0.7	2.0	8.0	2.2
15	0.5	1.3	2.8	1.0
20	0.4	0.8	1.6	0.6

FIG. 5. TABULATED RESULTS FROM FIG. 4

ture. The oil supplied by the maker should be used to the exclusion of all others.

When making tests, it must be constantly borne in mind that the circuit is left without protection and caution must be used that an overload does not occur in the interval of testing. Some modern boards have their relays arranged with testing switches which disconnect a relay but connect in a spare for protection during test. Even in this case too much caution cannot be used to insure against material damage, personal injury and avoidable interruptions.

Discrimination in Power Rates Forbidden

It was held by the North Carolina Supreme Court in the case of Salisbury & Spencer Railway Co. vs. Southern Power Co., in which a hydro-electric company induced the petitioner, another electric company chartered to retail current, to abandon its steam plant for generating current and to buy current from the hydro-electric company, that such hydro-electric company became a public utility in the sale of current for distribution by others, and cannot justify an attempted discrimination against petitioner on the ground that both petitioner and itself were chartered to generate current. Also the company in question, having almost a monopoly of water power, cannot discriminate against individuals or users of electric current on the ground that it has a right to select its customers.

In reaching this conclusion, the Court said:

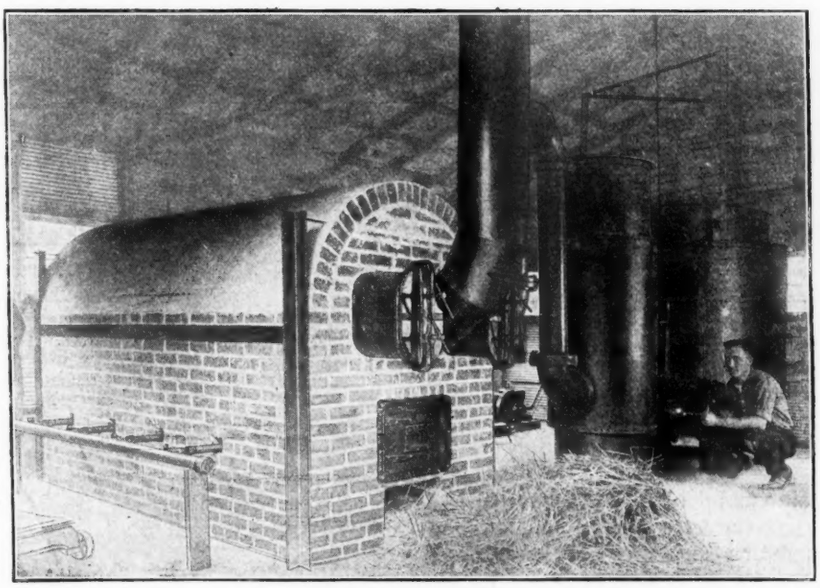
> It is of the highest importance that these claims of the defendant Southern Power Co. to discriminate in the rates charged by it to purchasers under like conditions should be clearly denied by the courts. If the defendant is thus permitted to charge cotton mills in which the owners of the defendant are interested the rate of 1.1, while it charges the plaintiffs and other mills and industries in which it is not interested 1.88, or a higher rate than it does others in like condition, it follows that in a comparatively brief time the defendant will have the power to destroy, and thereby acquire the ownership of, all the other cotton mills and industrial plants in the state, and thus create a cotton-mill monopoly wherever its lines extend; for by reason of the approaching exhaustion of the coal mines and the interruption of their operations, there can soon be left available for large industrial plants no other power than the monopolized water power of the state.

The Production of Gas by the Destructive Distillation of Straw

By HARRY E. ROETHE
Bureau of Chemistry, United States Department of Agriculture

ALTHOUGH numerous experiments have been conducted in Canada and the United States during recent years on the production of gas by the destructive distillation of straw, very little information has been made public regarding the utilization of such material by means of this process.

If dry straw is sufficiently heated in a closed container or retort, gas is given off which may be used in much the same manner and for similar purposes as coal gas. The byproducts consist of tar, ammonia and carbon char or residue. The process has also a possible application to the various industries confronted with the problem of economically disposing of waste fibrous or cellulose material. The destructive or dry distillation of straw is typical of the utilization in this manner of many waste vegetable products. In this connection corn stover, corn cobs, cane trash, various straws and saw- and planing-mill waste (wood), etc., might be mentioned. Realizing the possible application of the process to the farm, the Bureau of Chemistry, United States Department of Agriculture, is studying the problem as related to the farm or rural community.



STRAW-GAS PRODUCER

A gas-producing plant has been set up on the Government farms at Arlington, Va., to be operated as a small unit. Here tests will be made on the production of gas from various straws and other cellulose materials.

The unit as installed by the Bureau is shown in the illustration and consists of:

1. A cylindrical, sheet-steel retort eight feet long and three feet in diameter, incased in brick and resting on its horizontal axis above a firebox. In cross-section the retort is doughnut-shaped, permitting the passage of flue gases around the retort and back through the center.

2. A cylindrical, sheet-steel scrubber seven feet high and two feet in diameter, placed in a vertical position, and partly filled with water. The scrubber is equipped with several screens for supporting trays of coke to give greater scrubbing surface.

3. A steel, water-chamber gasometer of the ordinary type, having a capacity of approximately one hundred cubic feet, for storing the gas produced.

The volumetric capacity of the retort is a little over fifty cubic feet, accommodating a maximum of about two hundred pounds of unbaled straw. A charge of this quantity can be carbonized in thirty to forty-five minutes. The gasometer mentioned is not of sufficient capacity to store at one time all the gas produced from a maximum charge in the retort, lack of space and funds necessitating the installation of a small gasometer. The retort is charged with unbaled straw through the two oval openings at the front end, after which the two cover plates, equipped with gaskets, are tightly clamped in place. Heat is applied to the retort from beneath by the burning of straw or wood in the firebox. Gas begins to come off when a temperature of about 200 deg. C. (392 deg. F.) is reached, with a maximum production between temperatures of 500 and 600 deg. C. The gas generated is conducted through a six-inch pipe connected at the side of one of the front charging doors, to the scrubber, where it is cleaned by passing upward through water and coke; it then enters the gasometer for storage.

After the initial production of gas the carbonizing process can be continued, using as fuel a portion of the gas already generated for supplying the necessary heat. This is accomplished by means of several gas burners made of one-inch pipes, each equipped with a single row of holes and a mixing valve arranged transversely in the firebox. These burners are connected to a pipe line extending to the gasometer.

Based on the results of Canadian experiments, one ton of sun-dried wheat straw produces approximately 10,000 cu.ft. of purified gas, 600 to 650 lb. of carbon residue, which may be readily powdered to a very fine consistency, and about 10 gal. of tarry liquid. The gas has a calorific value of about 400 B.t.u. per cubic foot, burns with a blue flame and has a slight odor. The combustible constituents of the gas are carbon monoxide, methane and hydrogen. A ton of straw is equivalent to 32 gal. gasoline.

The equipment installed on the Government farms, while suitable for demonstrational and experimental purposes, does not represent the latest ideas and improvements which should later be incorporated in a perfected unit. The present unit will be used in conducting tests on the quality and quantity of gas and byproducts obtained by the destructive distillation of various fibrous and cellulose materials common to the farm or generally considered as waste. A study will also be made of the utilization of this gas for heating, lighting and power purposes on the farm. For this purpose miscellaneous equipment has been provided, consisting of several Welsbach-mantle lamps, a gas hotplate, a gas reflector stove, and a 1½ hp. stationary gasoline engine. These devices will be operated on the gas produced from the various materials.

While straw gas is not a new proposition, not a great deal has been done in perfecting equipment or in determining the practicability of the process. If funds are available, these problems as related to the agricultural wastes will be carefully and extensively considered by the Bureau of Chemistry.

An effort will be made to design and construct the most simple, inexpensive and effective equipment possible, with a study of its adaptation to the farm. In this connection reference is made especially to the size and shape of the retort, the different methods for storing the gas produced, and charging of the retort with baled and unbaled straw. Many economic studies will be made, among which might be mentioned the cost of producing gas, time and labor required, quantity of raw material necessary and the utilization of the byproducts in the most effective manner. Determinations must be made as to whether the equipment will be more practical and satisfactory in the various sections of the country as a unit for the individual farm or as a community plant for a number of farms.

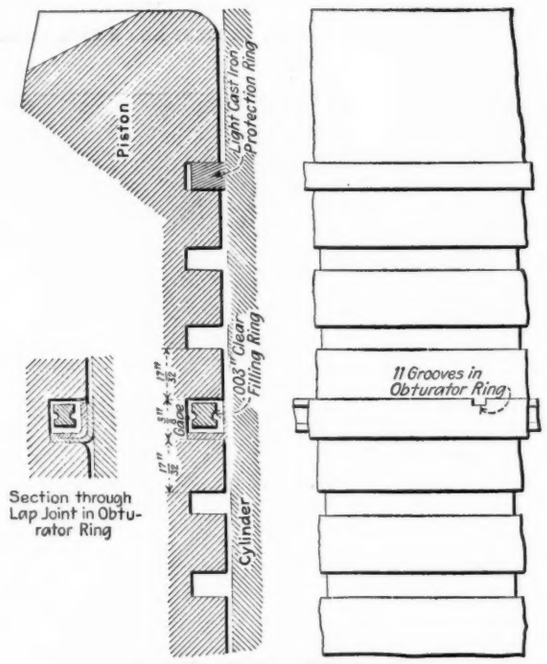
On account of the present shortage and high cost of gasoline the question has been asked, "Can straw gas be used for driving automobiles?" Tests have shown that this gas is very satisfactory for operating stationary internal-combustion engines. In several instances automobiles have been equipped with flexible bags containing about 300 cu.ft. of straw gas, a quantity sufficient to run the car fifteen miles. This arrangement was much the same as that used in England during the war for operating motor busses with coal gas. Straw gas for automotive power at least has possibilities. However, it will never be practical for this purpose under present conditions until the gas has been compressed or condensed, permitting the carrying of sufficient quantities on the automotive vehicle in a satisfactory and practical manner.

Aluminum Pistons for Diesel Engines

In an article read before the Institution of Naval Architects and reported in *Engineering*, C. J. Hawkes, R.N., discussed the use of aluminum pistons on an experimental Diesel engine. The piston design finally decided upon had the trunk divided at the gudgeon-pin center, the bearings for the pin being carried between the two halves. Lubrication was secured by force feed through the connecting rod from the crankpin. The gudgeon pin was fast in the rod while the pin ends rested in the bearings mentioned. Six rings and one "obturator" were used; the type of ring and location appear in the sketch. The weights of the aluminum-alloy piston and I-section rods are appreciably less than the weights of these parts on the usual Diesel, with the result that the inertia forces at 500 r.p.m. are the same as in the latter at 380 r.p.m.

The coefficient of linear expansion and the thermal conductivity are greater for aluminum than for cast iron; consequently it was found necessary to make the clearance about one and one-half the usual clearance to avoid seizing. Aluminum is of advantage if seizing does occur, since it never damages the liner, while a cast-iron piston, on seizing, always scores the liner. Furthermore, on cooling, a seized aluminum piston always frees itself.

There is no doubt, so far as present experience is concerned, that aluminum-alloy pistons, although greater in first cost, have many advantages over the standard



PISTON WITH OBTURATOR

cast-iron piston. In high-speed engines such as submarine units the decrease of weight and the allowable higher speeds are of practical benefit.

The arrangement of the L-sectioned obturator ring is shown in the sketch. This ring is of phosphor bronze, being 0.05 in. thick. A lap joint, riveted and silver-soldered to one end of the ring, insures gas-tightness. It was found that the ring bore against the cylinder only in spots and a number of slots $\frac{1}{32}$ in. wide were cut in the edge of the ring. This allowed the ring to press outward against the wall, insuring gas-tightness. Originally, some of the piston rings were left off, but to prevent the knocking or side slap of the piston the rings below the obturator were replaced. If the clearance had been less, no doubt the knocking would not have occurred even though the lower rings were absent.

After running for 150 hours the obturator ring was measured and showed a wear of 0.001 in. So far the ring has been tested under favorable conditions, and it is impossible to predict what results were to be secured in ordinary service over long periods of operation.

Refrigeration Study Course—XVIII. Cold-Storage and Packing-House Refrigeration

By H. J. MACINTIRE
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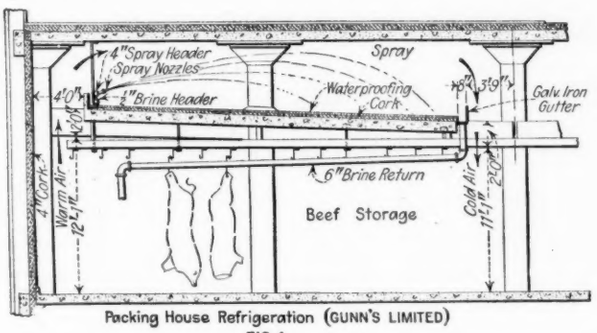
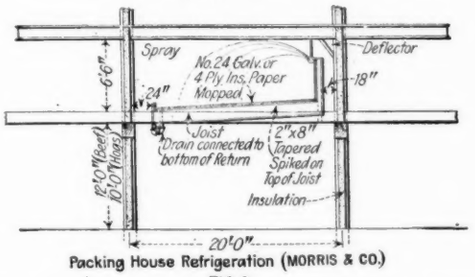
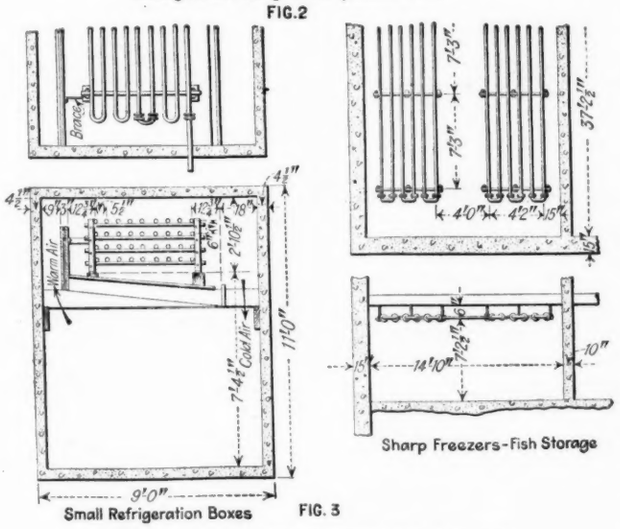
IN THE previous article the matter of the applications of refrigeration was taken up, and it was shown that the high-pressure side was the same in nearly every case, except when stage compression was found desirable or the absorption machine was used. In other words, the application of refrigeration affects the low-pressure side, and it is here that the details become so varied and numerous. Ice making was described in some detail, and the fact that raw-water can ice making is becoming the favorite method generally was mentioned and reasons were given for its preference. Because of its bulk ice must not be handled much and is best produced in close proximity to the zone where it is to be consumed; for this reason artificial ice is rapidly replacing natural ice even where the latter is plentiful. Next to the importance of ice making comes the business of cold storage, which includes chilling, sharp freezers, and coolers for the preservation and curing of meats, fish, vegetables and fruits. Before going into the subject of cold storage, it will be wise to give the reason for its use. Meats are chilled quickly because otherwise the natural process of decay will set in. Vegetables, fruits, dairy products, etc., are kept at or about the point of freezing of water because it has been found that the bacilli which cause decay are prevented from growing actively when held at this temperature. Cold storage cannot preserve goods indefinitely (except certain meats when kept at extremely low temperatures) because the bacteria keep growing and increasing in numbers even at cold-storage temperatures. A large number of different goods cannot be frozen—fruits and vegetables for instance—without spoiling the cell formation and the internal structure of the goods, and therefore such goods cannot be kept in cold storage for more than a few months. Besides the matter of the temperature, there is the factor of the humidity of the air, which affects not only the holding power of the food stuffs but the quality as well. This is more marked in some cases than in others, but with eggs too great a humidity will spoil them and too low a humidity will cause them to shrink. In the packing-house chill room, dense clouds of steam come off the freshly killed animals, and the manner of refrigeration must also provide a convenient means of removing this vapor. Vegetables, fruits, etc., dry out during the holding process, which increases the humidity. As a moist air is bad for cold-storage goods, the refrigerating plant must provide the necessary means of removing this surplus water vapor and keep the temperature and the humidity correct for the particular goods being stored, this being different for each variety of foodstuffs. The humidity, as a rough rule, must be in the neighborhood of 70 per cent. The accumulation of frost on the expansion piping is an indication of the removal of moisture from the air in the room. There is no set rule in regard to the use of direct expansion or brine cold-storage piping. The same plant may have both systems, as, for example, the Bell Street and the Spokane Street plants of the Port of Seattle, Wash. Packing plants use brine for the greater part of their work, although one large company at least has little or no brine refrigeration. This is because some of the load is heavy and is of short duration and can be handled well by the use of brine storage tanks and a smaller compressor running a greater part of the time. Also it is safer to use brine where the pipes are exposed and are subject to accident. In addition the chill rooms are usually designed to have a loft with brine sprays, or a brine curtain, as brine can pull down the temperature more quickly and absorb the moisture better than any other system. (See Fig. 1.)







FIGS. 1 TO 3. COLD-STORAGE PIPING

On the other hand, it is possible to operate compressors on the direct-expansion system more economically than with the brine system, because the boiling ammonia cools the air directly instead of indirectly by the use of brine. But it must be remembered that the direct-expansion system must be carefully laid out so as to return the gaseous ammonia with the least possible pressure drop to the compressor.

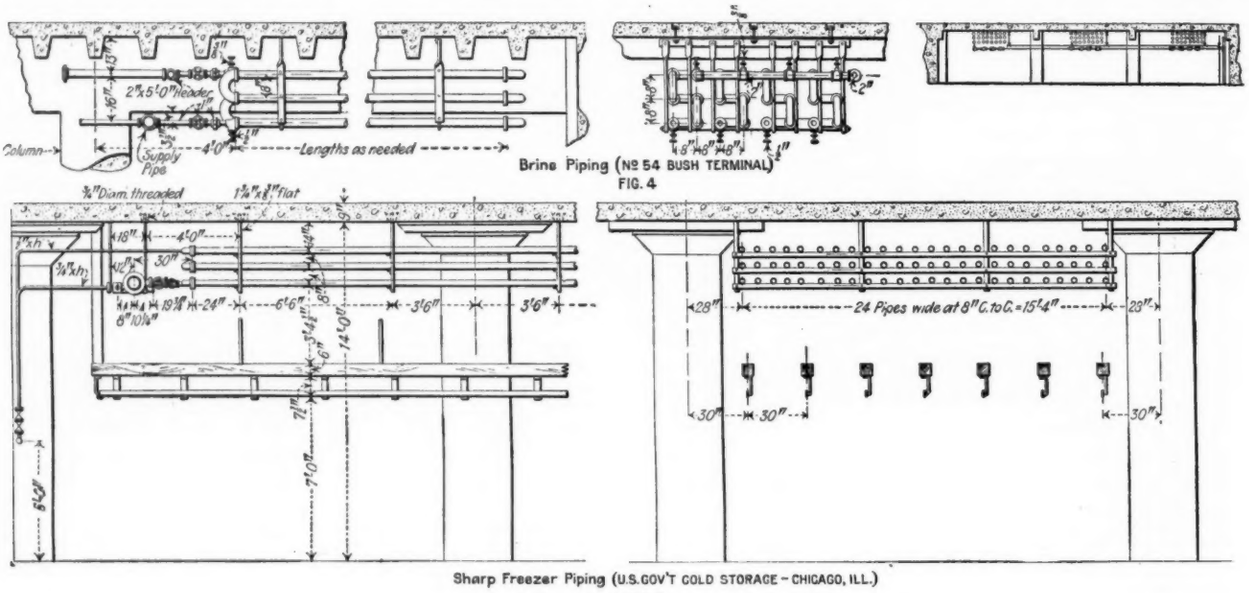
In a recent issue of *Power* were described the changes that have been made in the Anheuser-Busch plant, showing the necessity of unity in the piping design. The trouble in this plant was that it grew like "Topsey" and soon was a mass of large and small pipes of every description. Other factors that must be considered in deciding on the type of piping are the effect of the goods held in storage by a break in the pipe line, the cost of the ammonia piping as compared with brine piping, cost of the initial charge of ammonia, and its losses due to leaks or corrosion of the pipe line. The brine system is self-contained, having, with the exception of the ammonia condensers, the entire high side in the engine room under the easy control of the operator. It is to be remembered, however, that extra equipment is necessary with the use of brine, namely, the brine coolers, the brine pumps and the power necessary to circulate the brine. It may be added here again that the absorption system almost always uses brine, as direct expansion is not so advantageous as in the case of the compression system.

TABLE I. COLD STORAGE PRACTICE

Temperature of Storage, Deg. F.	Humidity, per Cent	Allowances
		1 bbl. = 31½ gal. of 231 cu.in. each. 1 bushel = 1.245 cu.ft. = 2,150.4 cu.in.
35	80 to 90	1 bbl. potatoes = 5 cu.ft. = 180 lb. = 2½ bushels.
32	.....	1 box cheese = 60 lb. = 2 cu.ft.
30 to 31	75	1 case eggs = 30 doz. = 50—70 lb. = 2½ cu.ft. = 12-x13x25.
2	.....	1 tub butter = 63 lb. = 1½ or 2 cu.ft. (piles not over 6 in.)
30 to 35	85	1 bbl. apples = 150 lb., 5 cu.ft. = 2½ bushels.
34	.....	1 crate celery = 10 cu.ft. = 140 lb. = 24x24x30 in. (4 ft. high).
34	80 to 90	1 bbl. vegetables = 5 cu.ft., piles 5 ft. high.
35	.....	1 box oranges (packed on end) = 4 cu.ft., 70 lb. = boxes 15 x 15 x 30.

Aisles—Allow ½ for eggs, celery and oranges.
Allow ⅓ for potatoes and vegetables.
Allow ¼ for mutton, pork, poultry (ft. high).
Specific gravity of boned beef = 1.073 = 67.2 lb. per cu.ft.

The sharp freezer is the term used for a cold-storage room which is held at or near zero degrees F. It may have better insulation than the ordinary cold-storage room, usually about six inches of corkboard, and it generally has an ante-room. The piping has to be heavy to



FIGS. 4 AND 5. BRINE PIPING

Bunker Coils Are Used

To better circulate the air, giving more ready control to both temperature and humidity, the outside bunker coil is used. In brief, this is an arrangement of coils in a separate loft or room, so arranged that the air may be forced through at a moderate velocity (where it is cooled to the proper temperature) and then through ducts to the distributing openings. The return is usually the reverse of the feed lines.

Such a system is recommended because it removes all piping from the cold-storage room. With care in the design a uniform temperature is possible and there is less danger of excessive cooling in certain parts of the storage room. Power must be provided to drive the fan which should be carefully selected so as to require the least power input for the volume of air circulated. But, whereas, less piping may be required than with the ordinary system on account of better heat transmission, there are some objectionable features. The motive power necessary for the fan also heats the air and requires additional refrigeration to neutralize it. The main objection to bunker coils, however, is in the matter of their cleaning. Usually, the coils are close together and, combined with the baffles, make a difficult piece of equipment to clean. As the ice accumulates on the pipes, the heat-transfer rate will drop until either the pipes are clean or service is unsatisfactory. This point is mentioned here because in the case of ice-cream hardening rooms the bunker coil is being replaced. The lack of success with hardening rooms is purely a matter of operation, but this service is the "court" of last resort when it comes to the proper design of a new refrigeration plant.

The Sharp Freezer Room

carry the heat leakage, which may be as great as double that of the general storage room for fruits and vegetables which are held at from 36 to 40 deg. F. Sharp freezers are designed usually for fish, frozen meats, eggs in bulk, etc. The temperatures carried are usually between 0 and —15 deg. F.

It is hardly within the scope of a study course to go much into detail except in fundamentals. The storing of goods, the duration of storage, the height of the boxes or packages, the amount of aisle, etc., are important details, but not necessarily of the kind that the operating engineer need keep in mind. A few figures are included, however, for handy reference. Particular attention is called to the piping layouts, which are all recent designs and typical of the kind of service being performed.

Do not put second-grade goods in storage. Cold-storage goods should be of the best quality. Fruits and vegetables should be carefully handled to keep them from unnecessary injury, and they must be re-sorted, after a period of time depending on the kind of goods, to remove the sprouts, spoiled parts or soiled containers.

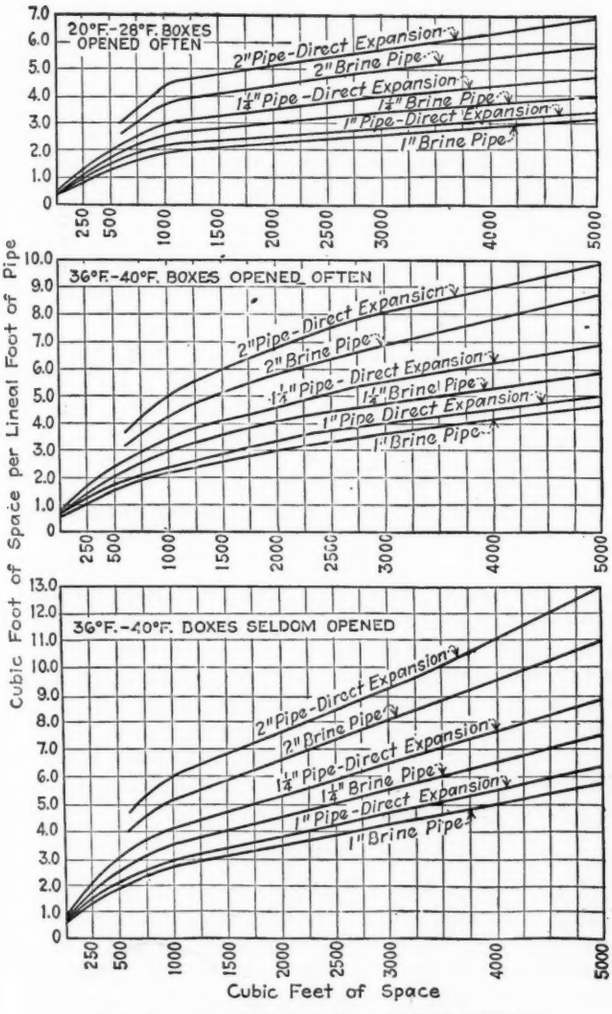


FIG. 6. VOLUME OF STORAGE PER LINEAR FOOT OF PIPE

Several curves showing the ratios of room space to piping and room space per ton of refrigeration are given. These curves show the cubic feet of refrigerator space allowed per linear foot of pipe. In each table the reader will note that this ratio is low for small storage rooms, increasing as the size of the room increases. For rooms that are opened frequently, the ratio is low. Considerable thought should be given to the entrances of rooms that are opened frequently to avoid excessive losses through the doors. A large saving of refrigerator can be made by the installation of proper door fittings and in all arrangements whereby the duration of opening is reduced to a minimum. There is much carelessness in this matter in the practice of many plants.

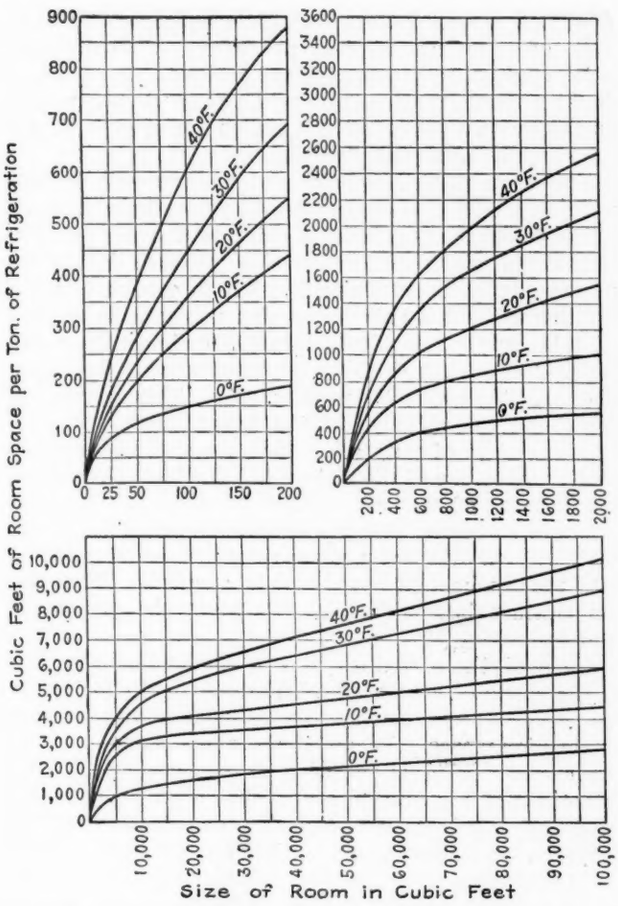


FIG. 7. CUBIC FEET OF ROOM SPACE PER TON OF REFRIGERATION

If the crank bearing of a Diesel engine is run slack, the inertia of the piston and rod as the crank passes top center may exert such a stress on the big end bolts as to elongate them. This condition will ultimately result in fracture of the bolts. In securing crankpin clearance, remove all shims, draw up the two bearing halves snugly against the pin; then measure with a clearance gage the distance between the two halves. This amount plus 0.006 in. is the thickness of shims required. In inserting shims between the two halves of the crankpin bearing, place equal amounts on each side. If this is not done, the bolt will be bent when drawing up. At each overhauling of the engine the big end bolts should be examined for flaws. Usually, any fracture starts at the root of a thread. A magnifying glass comes in very handy.

Behavior of Semi-Diesel Engines

Explanation of the Causes of Preignition—Practically All Such Occurrences Are Due to Mechanical Defects and Can Be Avoided

THE several letters that have appeared in *Power* of late, concerning pounding in semi-Diesel engines, fail to explain the real trouble. Without doubt a semi-Diesel engine will pound on heavy load as the writers state, but the reason for it goes deeper than any of them have revealed.

The term semi-Diesel is used to cover all engines wherein pure air is compressed in the cylinder and the oil is injected at a definite point in the compression stroke and where the compression pressure due to the decrease in cylinder volume is not high enough to cause ignition without the air of some hot surface. In engines of this type air is blown into the cylinder from the inclosed crankcase or from the compressor side of the piston, at the end of the power stroke. This scavenging air clears the cylinder of the burnt gases and supplies a charge of pure air. This air is compressed on the return stroke of the piston. As the piston advances, the density of the air charge becomes greater, the pressure increases, and the temperature is correspondingly raised. At the proper point the oil is injected into the combustion space and is gasified. When the temperature becomes sufficiently high, the gas vapor ignites.

Some of these engines have a combustion chamber in the shape of a bulb or spherical cavity in the cylinder head. Some employ the cylinder cavity as the combustion space. In all the designs some part of the cylinder head is uncooled or so poorly cooled as to remain at high temperature; this high temperature condition is necessary to gasify and ignite the oil properly. It follows that the higher the value at which the temperature can be maintained the quicker and more perfectly will the fuel be vaporized, provided the temperature is not so high as to cause oil "cracking."

Time of Oil Injection

From a consideration of these conditions it can be concluded that the higher the combustion-cavity temperature the later may be the point of fuel injection. None of the modern engines, however, is timed to inject oil earlier than 30 deg. ahead of dead center. This represents a piston position about 10 per cent from dead center. Fig. 1 shows the relative position of the piston and crank at the beginning of fuel injection. The air within the combustion space is highly concentrated, and the oil entering this dense, highly heated mass of air is rapidly vaporized and ignited.

It is quite possible that preignition, or ignition of the newly injected fuel charge, could occur if the cylinder-wall temperature was excessively high or the injection very early. There is no doubt that at high temperatures the oil undergoes a chemical disintegration, or cracking, upon striking a hot surface with the evolution of light hydrocarbons and the deposition of the heavy, sooty residual. This light gas undoubtedly will ignite more quickly than will the oil gas if the dissociation does not take place. But this type of preignition is always preceded by what may be termed detonation. The pounding called preignition, however, usually occurs after dead center is passed and the noise is due to the excessively rapid rate of burning. Apparently, as the oil leaves the ignition nozzle it is broken up into gas. The ignition of the fuel occurs at the point of highest temperature, which of course is in the neighborhood of the hot, uncooled surface of the combustion chamber. The explosion gives forth a decidedly metallic sound that can be distinguished from true preignition, although many engineers unknowingly clasify it as preignition. The wave of high pressure and temperature produced by the detonation travels across the combustion space, causing the gas vapors and air to be highly compressed and raised in temperature

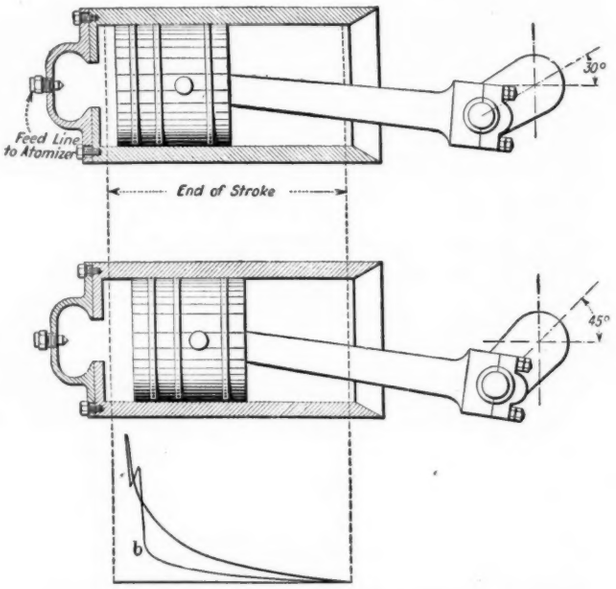


FIG. 1. CRANK POSITION AT THE INJECTION POINT
FIG. 2. CRANK POSITION AT PREIGNITION

until the entire fuel charge explodes instantaneously. The resulting pressure produces a severe racking pound if the explosion has occurred before dead center. Even if this instantaneous explosion takes place at or after dead center, a characteristic thump is emitted. Such ignitions can take place only with excessively high combustion-chamber wall temperatures. It is obvious that the introduction of a water jet will keep the temperature below this point.

True Preignition

If an engine has a decidedly early fuel injection timing, the vaporized charge will explode early in the compression stroke provided the cylinder temperature reaches the self-ignition point at this time. If this takes place before dead center, the resulting explosion is a true characteristic preignition. It should be understood that the injection must be very early to allow the entire program of detonation and preignition to occur before dead center. Even with gasoline the usual timing is not sufficient to produce preignition, even though the initial ignition be made positive by spark

plugs. Detonations will occur, but the cycle interval is insufficient to allow the complete procedure to take place before dead center. In semi-Diesel oil engines detonation is frequently noticed, especially on heavy loads where the cylinder temperature is high. But true preignition seldom occurs if the engine is in good mechanical condition.

In all designs of two-stroke-cycle semi-Diesel engines the injection of fuel starts, as has been stated, at or later than 30 deg. from dead center. If a full load condition is assumed, 25 deg. is probably the average injection point. The delivery of the fuel into the combustion chamber is complete in a few degrees of the crank circle ranging from 6 deg. in one engine to as much as 20 deg. in one or two other designs. If this fuel is injected and properly sprayed into the combustion space, all of it will be entirely vaporized or gasified at the end of the compression stroke.

If there exists within the combustion space sufficient oxygen to combine with all this gas vapor, the latter will be entirely consumed. On the other hand, if the amount of air is insufficient for perfect combustion some of the vapor will remain in its original state and will mix with the burnt gases and be blown out the exhaust when the exhaust ports are uncovered. This statement presumes a fair degree of scavenging effect. If, for any reason, all the burnt gases and oil vapors are not blown out of the cylinder, they will be trapped in the cylinder when the piston covers the exhaust ports. These vapors, mixing with the air charge, will attain their ignition point much before dead center; preignition, so-called, will then take place. This is because the temperature required for self-ignition of a fuel depends upon the time interval.

Cause of Holdover Ignition

It requires no argument to prove the statement that the degree of scavenging efficiency largely determines the question of this preignition, or, rather, "holdover" ignition. If the air currents succeed in removing all gases, burnt or unburnt, nothing remains in the cylinder to ignite. The design of the air ports and deflectors on the piston and the maintenance of these ports in a clean and unobstructed condition are of prime importance.

There exists a far more prevalent cause of these pre- or holdover ignitions. This is the action of the fuel nozzle or atomizer. All engineers will understand that the atomizer must spray the oil efficiently if complete combustion is to be secured. If the particles of oil entering the cylinder are fairly large in diameter, the time necessary to completely gasify the liquid is more than that occupied by the normal period of combustion. Some of this oil, the interior of the oil particles, is not completely gasified until the power stroke is completed. Part of the gas is trapped in the cylinder and explodes early in the compression stroke. The fuel atomizer must break up the oil charge into a fine fog. The design of the pump largely governs the spraying effect of the nozzle. If the velocity of the oil discharge varies with the load change, then the atomizing effect at the point of low velocity will be poor. Undoubtedly, a pump in which the velocity of discharge is constant at all loads gives the best atomizing efficiency.

The design of the atomizer can well be claimed to exert the chief effect in causing or preventing these so-called preignitions. If the check valve does not cut off the fuel inflow sharply at the end of the delivery, drops of oil will continue to enter the combustion chamber during the power stroke. This oil will vaporize and part of it will be trapped in the cylinder. Consequently the fuel nozzle check must work perfectly to avoid this condition. The nozzle must actually break up the oil and not merely allow it to jet into the engine.

Four-Cycle Semi-Diesel Seldom Preignites

It is seldom that a four-stroke-cycle semi-Diesel engine preignites no matter what condition the atomizer is in. This is due principally to the better scavenging effect secured. On the exhaust stroke of the piston all the gases, burnt and unburnt, are expelled; there remains nothing to ignite since only pure air is contained in the cylinder on the compression stroke.

It is a matter of observation that, if no water injection is used, an engine having a separate combustion chamber in the cylinder head will not preignite on loads below three-quarters, while an engine where the fuel is deposited in the cylinder cavity will preignite at all but very low loads if the atomizer leaks or the scavenging is poor. The explanation is found in the segregation of the oil vapor in the combustion chamber. At the end of the power stroke the scavenging air removes the burnt gases from the cylinder, but the narrowness of the passage into the combustion chamber prevents its scavenging. The chamber is then left filled with burnt gases. If any oil leaks into it, the oil vapor is mixed with burnt gases and will not explode until the advancing piston forces pure air into the cavity. This will not occur very early in the compression stroke. If the load is heavy and some of the oil vapor fails to burn at the proper time, this vapor, increased by the dribble, fills the combustion space and flows into the cylinder and, mixing with the air, fires early.

That the pounding heard in the cylinder is not due to preignition of the fresh fuel charge, but results from the ignition of a hangover charge, is proved by the actual indicator diagram in Fig. 2. Here the almost vertical pressure line in the compression curve is produced by a preignition which took place at *b*, much in advance of the point of injection of the fuel charge. This is evidence that the fuel that exploded was left over from a prior charge or dribbled into the cylinder during the early part of the compression stroke.

Water Injection

To maintain the cylinder at a temperature below the ignition point during all but the final part of the compression stroke, most engine builders resort to water injection into the cylinder. The water absorbs enough of the heat in the cylinder to prevent a high temperature until the end of the compression stroke is reached. The water serves to decrease the rate of combustion, thereby avoiding detonations. With such precaution preignition or "holdover" ignition is positively avoided. Engines of the "dry" type always have the combustion chamber in the cylinder head, and attempt is made to prevent preignition by isolation or stratification of the gas vapor. The water cooling of the combustion chamber, if it can be regulated, will assist toward keeping the temperature down. These preventives are not altogether successful. It is the universal experience that many dry engines tend to develop the so-called preignition on full load. When nothing but

detonation or a metallic sounding explosion is heard, no loss of power is observed and the engine operates quite satisfactorily, although the exhaust may be smoky. If preignition does occur, increased water injection will eliminate it on a wet engine; on a dry engine a reduction of the load is necessary. If an engine has customarily carried the load without pounding, it is natural to expect that the fuel nozzle has begun to leak if a pound develops. A second source of pounding is poor scavenging. This is occasioned by the air port or exhaust ports clogging with dirt so that the scavenging process is indifferently performed.

Above all else, the engineer should realize that what is known as preignition in a gasoline engine cannot occur in a semi-Diesel engine—the preignition heard is a holdover ignition. When this occurs generally it is due to lack of cooling on heavy loads, leaky or imperfectly designed atomizer nozzle or to clogged air or exhaust ports. If the engine is cold, it sometimes happens that the fuel charge is not completely burned and explodes early on the next stroke. This is always accompanied by racing of the engine, missed explosions and smoky exhaust.

The McKenzie Forced-Draft Chain-Grate Stoker

With fuel prices high and equipment costing double former values, there has been a growing demand in the boiler room for higher rates of combustion, the primary idea being to increase the returns on the initial investment. The activity in the chain-grate field has been marked. Numerous forced-draft stokers of this type have been developed and, while still in the experimental stage, seem to show some improvement; that is, burn more coal per square foot of grate than was possible with natural draft.

One of the most recent developments in this field is the combination forced- and natural-draft chain-grate stoker of the McKenzie Furnace Co., of Chicago. As will be apparent from the illustrations, light loads may be carried on natural draft and forced draft applied for demands above rating. The system provided to distribute air under pressure over the entire grate area or to any section desired, is unusually simple and, in the initial installation of the new stoker, is reported to have given excellent results. Briefly, it consists of a main air duct entering at the front of the furnace and extending back in the side wall for the full length of the stoker. The duct, however, is not built into the wall, so that it may be pulled out of the furnace along with the stoker. From this duct transverse air chambers, tapering in section, with perforations in an arched top to discharge the air, lead across the grate area. These air chambers alternate with the rollers supporting the upper run of links, with enough space between to admit air from underneath the stoker for natural-draft operation. The number of air chambers will depend upon the length of the stoker, but in the usual installation will range from 8 to 12.

Division of the air supply is thus greater than usual, and the distribution is effected by sliding dampers placed over the ends of the air chambers and operated by pull rods from the front of the stoker. With this arrangement no necessity has been found for closing up the stoker front. In operation there has been no evidence of the gases passing out at the gate nor of the air from the chambers bypassing down below the stoker. At the sides of the stoker frames there are seal plates, as indicated in the detail view.

When using forced draft, the air is admitted into the main side duct at a pressure of 2 oz., but when all the dampers that regulate the supply of air to the small transverse chambers are open wide, this pressure reduces to 1½ oz. As the top of the air chamber is convex, the air is discharged through the various holes in the top at different angles, giving an even distribution of air over the grate area in the immediate vicinity. As previously stated, there is sufficient space between the air chambers and the rollers to allow air to pass up

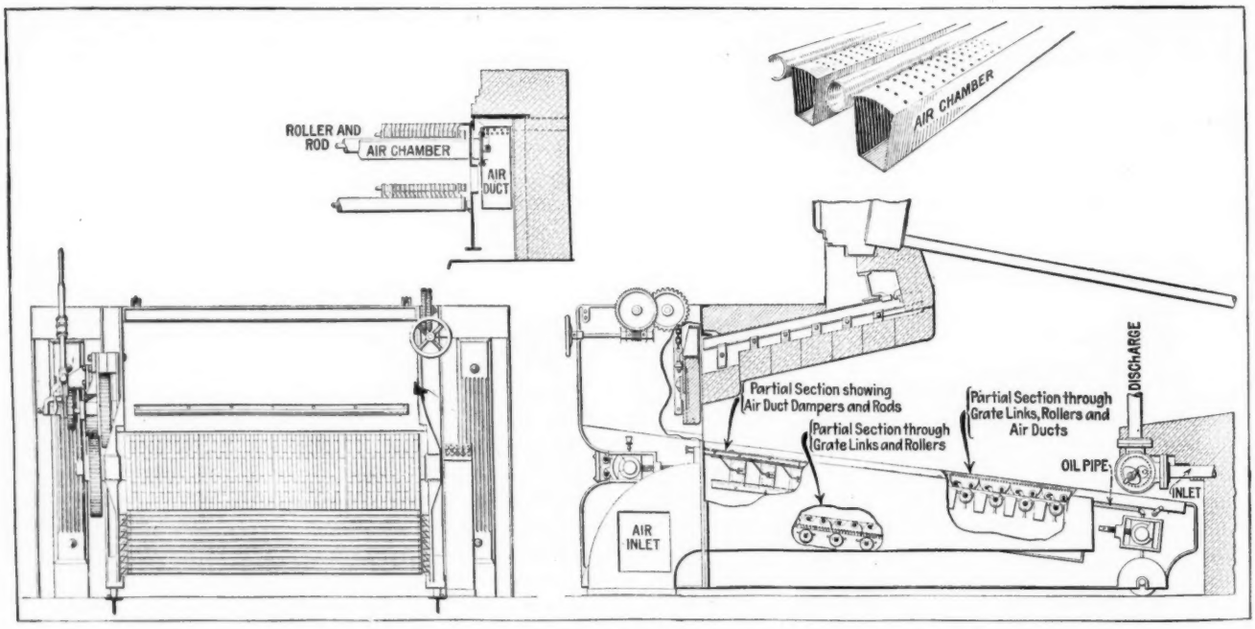


FIG. 1. DETAIL VIEWS SHOWING THE DESIGN OF THE NEW McKENZIE FORCED DRAFT STOKER

from below when the stoker is operating on natural draft. In addition the dampers of the forced-draft system are opened wide and a door in the main air duct at the front of the stoker is removed to give a sufficient supply of air for ordinary loads.

To give the expanding volume for the gases, particularly needed during high rates of combustion, the stoker pitches toward the rear and the arch slopes upward, as indicated in the longitudinal view of the stoker. The arch is of the flat suspended type, designed

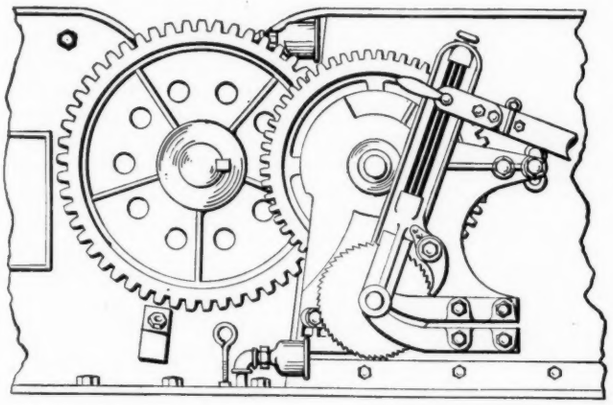


FIG. 2. SPUR-GEAR DRIVE OF STOKER

so that each individual tile can be removed without disturbing any of the others. To make this possible, each tile is suspended individually and the necessary clearances are allowed for expansion. The supporting members are provided with extensions so that the rear of the arch may be replaced without disturbing the main body of the framework.

From the same longitudinal view the design of the feed gate will be evident. It is highly geared to a hand-wheel operated at the stoker front. The drive is of the substantial spur-gear type shown in Fig. 2. The speed of the chain is regulated through the ratchet lever, and a tension spring is provided in the connecting rod between the lever arm and the eccentric to protect the stoker against any sudden blocking of grate travel. The

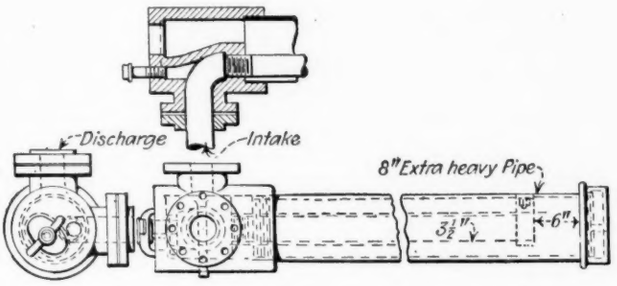


FIG. 3. WATER-BACK DESIGNED FOR CONVENIENT CLEANING

grate tension can be adjusted from front or rear. For burning all Middle Western coals standard links of the design shown in the drawing are used, and special links with suitable air spaces for stokers that are to burn high-carbon bituminous coal, anthracite, lignite or coke breeze.

A feature varying from the usual is the water-back shown in Fig. 3. The external member is an 8-in. extra-heavy pipe which supports the overhang of the bridge wall. The inlet and discharge are at the same end. The water enters through a 3½-in. tube extending within the larger pipe almost to the far end. The return is through the large external pipe. When it is necessary to clean out the water-back, a hose is attached to the 1-in. nipple leading into the 3½-in. pipe, the hand-hole plate at the end of the fitting is removed, and the sediment or sludge that has collected is washed out.

Utilizing Freshet Water for Power Generation

By CLEMENS HERSCHEL*

With a properly designed venturi tube installed in the discharge of a hydraulic turbine, power output can be increased a maximum of 30 per cent by utilizing the freshet water that would otherwise run to waste over the dam.

IN A recent editorial on the "Need of a Hydraulic Laboratory," *Power* mentioned the loss of head due to back water and told how "to get, by the use of a greater quantity of water under a lesser head, as much power as with the lesser amount under the greater head for which the turbines were designed, and this with the same machines." Several such methods have been devised, and one of them, the "Fall Increaser," invented and tested at the Holyoke Public Testing Flume by the writer (also tested by Duebi in Zurich, Switzerland), will be described in this article, and includes the experience of the past ten years endeavoring to introduce this device.

Of course more wheel capacity would solve the problem, some of the wheels to stand idle during normal and low flows of the river. However, more wheels would mean more generators, more wheelpits, tailraces and a larger power house. The chief purpose of greater wheel capacity—that is, more units—is to guard against machinery accidents and to facilitate repairs, and not to utilize freshet water.

Saugey, of Geneva, Switzerland, proposed discharging the water from the forebay out through the turbine discharge water into the tailrace in times of freshets, thus increasing the velocity of the discharge from the turbines. Experiment with this crude apparatus showed it to have an efficiency of 3 per cent; that is, 3 per cent of the power due to the additional amount of water discharged into the tailrace under the existing head was by this means added to the power developed by the wheels without the device.

If the same quantity of water just referred to, instead of being merely allowed to impinge as a stream upon, and mingle with, the tailrace discharge, be allowed to flow through a properly constructed venturi tube, as in the figure and thus create suction at the throat of the tube, with the turbine discharging out of an

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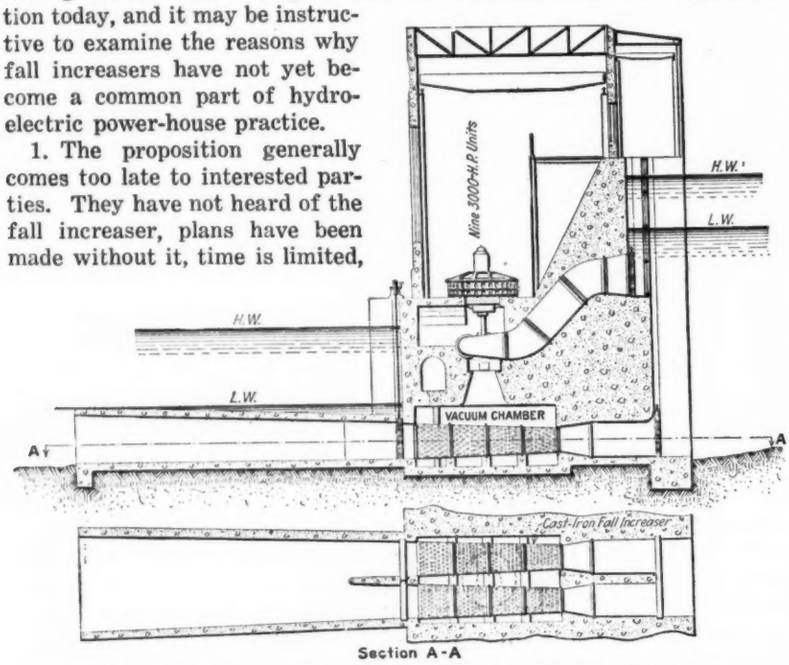
airtight chamber into which the turbine discharges, this same 3 per cent efficiency can be increased to over 30 per cent and can, by improvements that have naturally suggested themselves, be considerably bettered.

Five power plants have been built in the United States since Herschel's Fall Increaser was described in the public prints, which obtain only about 3 per cent of the energy from the excess water; when only at an insignificant additional expense the same water would have given them over 30 per cent. Such is the situation today, and it may be instructive to examine the reasons why fall increasers have not yet become a common part of hydroelectric power-house practice.

1. The proposition generally comes too late to interested parties. They have not heard of the fall increaser, plans have been made without it, time is limited,



SECTION THROUGH POWER PLANT, SHOWING LOCATION OF FALL INCREASER

or the commencement of the work is desired, and it is easy to go ahead without it. Allied to this is the disinclination of engineers to change plans that have once been settled upon.

2. Fall increasers cannot, practically, in the vast majority of cases, be added after the plant is built.

3. The power house must be at or near the dam, and the tailrace cannot be a long one.

4. About half the river sites met with have not sufficient back-water in times of flood or a sufficient number of days of flood in a year to justify a fall-increaser outfit. Each case must be studied individually.

Without additional operating costs, by use of the turbines and generators already installed, merely utilizing the water that otherwise would waste over the dam, an increase of annual output is accomplished with this device, at a first cost which is returned to the parties by from one to two years of normal operation; and this increase of income thereafter goes on without charge as long as the plant exists. The statement "no additional operating costs" may even be improved upon. Fall increasers allow the rakings of the trash racks to be pushed down into the increaser intake and run through, instead of being compelled to lift them up and bring them ashore, thus saving largely in one item of operating expenditure.

Auxiliary steam power is needed as a rule during times of low water, in order to produce a maximum return on the investment, the outflow of the Great Lakes alone excepted. When fall increasers are already installed, for the purpose just stated, they are more economical to keep up the normal output in times of flood water than to burn fuel in the steam-power plant for this purpose during times of high water. The value of half the fuel thus saved for fifteen years, computations made and agreed upon to begin with, is what the use of the fall increaser has been offered for.

The sectional view in the figure, from a design for actual use, will show the general construction of the fall increaser sufficiently clearly, with what has already been said, without detailed explanation. As first designed, a separate outlet for the turbine's discharge was provided to be used in times of low water. It is, however, believed that this made the design needlessly complicated. The holes in the venturi throat, that suck in the turbine discharge, have so great a sectional area the velocity through them is less than four feet per second; that is, less than three inches of head is lost through these holes when the full turbine discharge is passed through them during times of low and normal water; and it is believed that this is a small price to pay for the other advantages presented.

Electrical Power Production in Soviet Russia

The generation and distribution of electric power in Russia is under control of the Soviet department for electricity. This department manages 10 nationalized power plants, 45 nationalized factories for electrical machinery, telephones and telegraphs, and 19 works not yet nationalized. The aims of the Soviet government are to build new power plants and to supply electric current to farmers, sawmills, mines and to all larger foodstuff producers.

A statement issued by the Soviet government regarding the future of the electrical industry in Russia is full of optimism and goes so far as to say that all the resources of the country will be utilized by electric power, bringing the country to a state of prosperity unparalleled in its history. The figures showing the power production of the Moscow and Petrograd plants from January to April, 1920, show, however, that practical conditions are very far behind these aims of the Soviet government. In Moscow only three of the existing five power plants were running in January; the other two have been put to work later on with insignificant results. Only 8,000,000 kw.-hr. is produced in Moscow per month. In Petrograd the power production is still less and was in March at its highest point, with 6,800,000 kw.-hr. In these two cities nine of the ten nationalized power plants are situated. The electric works in the provinces, such as exist, are still in private hands, but are mostly shut down for want of fuel.

The Baumé gravity has no direct bearing on the adaptability of a fuel oil. It happens, however, that most oils have a gravity fairly in proportion to their adaptability as a fuel oil. With Mexican untopped oil of 16 deg. Bé., enough gasoline is present to produce the primary ignition.

Operation and Adjustment of Turbine Machinery XII—Oil Pumps

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

OIL PUMPS geared to the furnace are of one general type wherein a stream of oil is forced by two gears that mesh. The oil pressure is regulated by a relief valve that discharges the surplus oil into the reservoir. In some turbines the capacity of the oil pump is made close to that actually required by the oil system, so that there will be little unnecessary work for the oil to do.

Oil pumps that do not deliver the required volume and pressure should ordinarily be referred to the manufacturer, as they are so standardized that inability to perform is usually due to some defect of assembly or material. The main point in such pumps is to keep the clearance between the ends of the gears and the casing as small as possible (Fig. 1). This clearance is usually 0.002 to 0.004 in. Cases have been known where the standard clearance had been exceeded by 0.004 or 0.005 in. and a large reduction in the capacity of the pump resulted. An objection to the relief valve is the squealing noise that sometimes occurs. This can be corrected by using a spring of proper elasticity for regulating the relief pressure. Sometimes the spring used has too hard a temper, which can be reduced to advantage. It is often customary to place a strainer in the circulating system for the purpose of removing impurities such as lint, pieces of waste, core sand from the castings, broken-down oil deposits, and metal resulting from wear or cutting of moving parts. When the strainer becomes clogged the oil pressure drops, and if this should be on the suction side of the pump the pressure fall will be rapid. The strainer should therefore be frequently inspected. Dirt collects in excess when a turbine is first started or after repair work has been done.

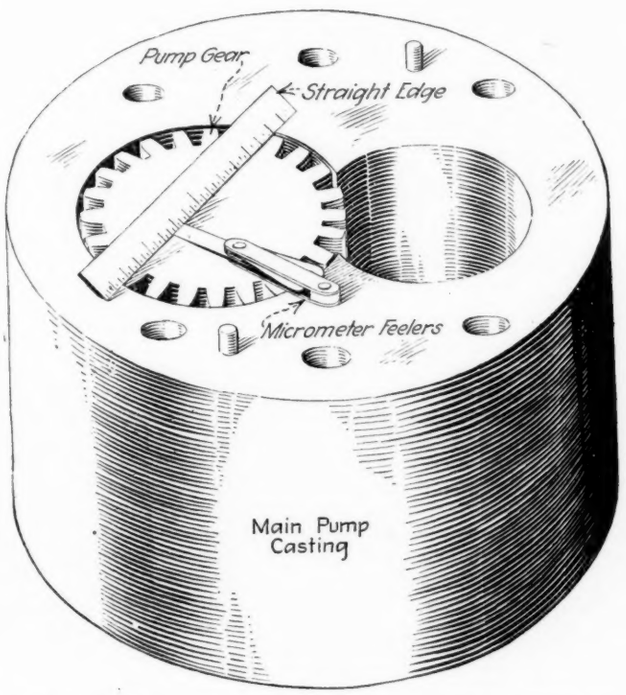


FIG. 1. MEASURING THE END CLEARANCE OF THE OIL PUMP GEAR

The usual method of cleaning the strainer is to shake out the large deposits and then blow steam through the wire mesh to clear the sticky material. This is not always effective, as, notwithstanding this treatment lint will stick to the meshes and often cause trouble when the strainer is replaced. A good way to clean the strainer is to pour some gasoline over it, let it partly evaporate, then touch a match to the mesh.

The piping system is usually arranged so that the strainer is bypassed automatically or else by hand-operated valves so that it can be withdrawn from the turbine while it is running. This procedure usually means the removal of a small quantity of oil from the system. The best time for cleaning the strainer is when the machine is shut down, if this is convenient.

Oil bafflers are for the purpose of reducing oil pressure so that one pump can be used for a high-pressure oil-valve gear cylinder and at the same time furnish low-pressure oil by means of the baffler for use in the bearings. Bafflers, which usually consist of a spiral passage for the oil, are so simple in character as to need no comment here.

Of all the various kinds of leaks which the engineer encounters in his daily experience there is none which usually present greater difficulties than oil under pressure. Few oil lines are actually tight. In almost all cases there is a damp spot or other evidence of a small leak. Oil lines can be made tight in every case if the proper methods are thoroughly followed. The "dopes" used in holding oil are shellac, soap, white lead and such corrosive substances as red lead and litharge. Oil lines are usually specified to be put up with shellac in the threaded joints. Shellac in this respect is sometimes effective, but with hot oil under pressure and some vibration of the piping it is seldom entirely satisfactory. The surest way to make pipe threads hold tight is to solder the connections. The threads of the pipe and fitting should be well tinned. The joint should be made up while these are hot enough to make the solder run a little. This will give a tight joint with brass piping. It is an easy and sure means. With iron pipe especially of large size, this method is not suitable. The best way to get such joints tight is to make sure that the threads are cut with good sharp tools. Thoroughly clean off these threads and then wipe with wood alcohol or turpentine to remove all traces of grease. Paint both threads with shellac and powdered graphite, or shellac and lampblack, and then screw tightly together. This will hold satisfactorily in most cases; if it is necessary to take more certain means soldering can then be resorted to.

Ground joints, such as those in bearing housings, can be made tight by using shellac and graphite in the

proper way. It is necessary not only to scrape and wipe the surfaces clean, but most of all, to cleanse them thoroughly with wood alcohol or similar solvent to remove the oil which is in the pores of the iron. Otherwise shellac will not hold tight, unless the joint is unusually well designed.

Gasket unions should be put up in a similar manner. Hydraulic gaskets or heavy cardboard are most satisfactory. Ball-seated unions can sometimes be held with a lead gasket or a gasket of cloth reinforced with shellac and graphite. These, however, are difficult to make tight. When a leaky one is encountered it can be made to hold by painting the threads with shellac and graphite and also packing the nut with wicking soaked in shellac and graphite. Everything should be wiped and cleaned as before described in preparation for the shellac. This method is shown in Fig. 2.

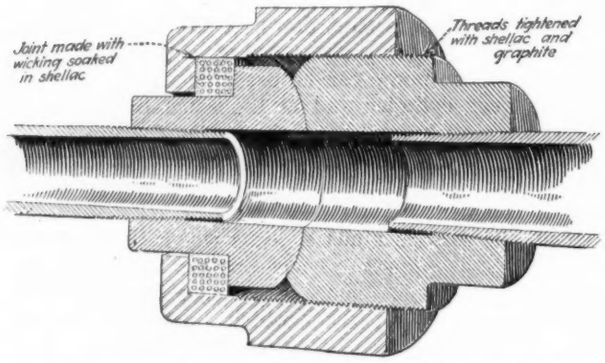


FIG. 2. HOW A BADLY LEAKING UNION MAY BE MADE TIGHT

Oil pumps are frequently made with several ground joints in such a manner that close clearance is necessary, therefore shellac and graphite would be too thick in such a joint and would interfere with the proper operation of the pump. The best means to employ is pure shellac after the surfaces have been properly cleansed.

Joints around governor casings where there is no bolt pressure for holding can easily be made tight by using a paper gasket or cotton thread together with the shellac and graphite.

Water pipes are sometimes equipped with glands where they are brought through the bearings housings. These glands are often difficult to make oiltight. Wicking soaked in heavy shellac will be found most effective provided the surfaces are all properly cleaned with alcohol.

Oil reservoirs are necessarily made of cast iron. This metal is naturally porous to oil. It is hardly advisable to attempt to correct such leaks where only an inappreciable amount filters through. If such a leak causes oil throwing, or if an oil tank contains sand holes or flaws so that a perceptible leak is encountered it can be made tight in the following manner: Clean off the paint and dirt with emery cloth and wash off with alcohol; when dry heat slowly with a blowtorch to a temperature above boiling where shellac will be boiled and baked into a hard covering. When at this temperature paint quickly with shellac and graphite. As soon as one coat hardens, apply another until the casting becomes cool. The shellac will stick closely to the pores of the metal and form a thoroughly tight covering.

It may be noticed that oil soaks out of the pores of the metal when it is first heated. Heating and cleaning should be repeated until such oil has been thoroughly removed. Wood alcohol is the secret of making shellac stick. This should be applied with a clean rag or brush.

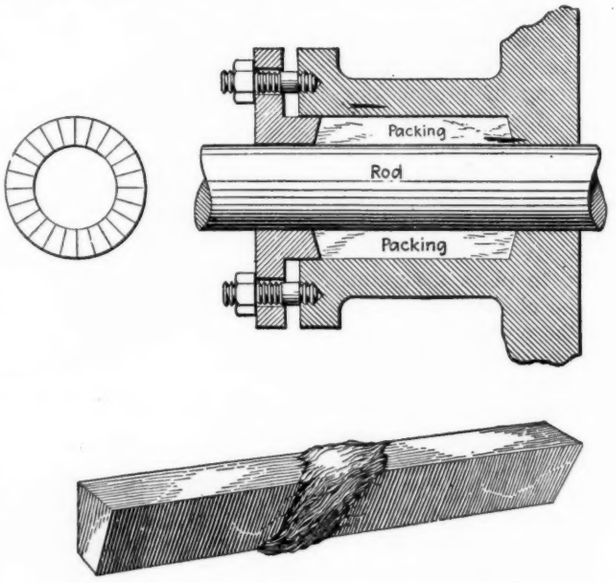
Other methods of making porous castings oiltight are tinning, brazing, plugging and welding. Tinning and brazing have been used in some instances; plugs are unsatisfactory for a truly porous casting, but are efficient where only a sand hole exists. The writer has had no direct experience with tinning and welding for this purpose and would appreciate advice from those who have had.

"Tiptop" Plastic Metallic Packing

Most piston-rod and valve-stem packing is placed in the stuffing boxes either by wrapping the packing around the rod or stem or by using split rings. There has recently, however, been put on the market a "Tiptop" packing that fits in the stuffing box lengthwise. Being wedge-shaped, it fits the stuffing box and rod, making practically a true circle when the packing is forced against the rod or valve stem as the gland is forced into place.

"Tiptop" packing, which is manufactured by the France Packing Co., Tacony, Philadelphia, Pa., is made of a soft shredded anti-friction alloy which is permeated with graphite and mica and then compressed into bars or segments, or into rings which may be cut diagonally with an ordinary jack-knife to fit the rod and box. It also comes in a loosely wound form like a string.

When made in bars, it can be cut into the required length to fit the stuffing box lengthwise, the lengths being packed around the rod as shown by the sketch. The packing is so soft that when it is compressed lengthwise it fills the wrinkles of the containing surfaces.



PLASTIC PACKING APPLIED TO STUFFING BOX LENGTHWISE

This packing is recommended for Corliss valve stems, steam and water valve stems, small valve stems on engines or pumps, water plungers on pumps, expansion joints or on any rod or tsem that travels in line. It is made for superheated steam and is guaranteed not harden in the stuffing box.

Pump Problems

By Roland Lester Tullis

Thoughtlessness or lack of knowledge on the part of the engineer when installing machinery often leads to an unlimited amount of trouble. I was visiting a plant one day when the engineer showed me a duplex pump that was giving him a great deal of annoyance. He complained that the pump was continually blowing out the head gaskets on the pump end; two or three of the heads had been cracked or broken, and the valve cover on the pump end had been broken in like manner. He was also having trouble with the plunger packing and the pump valves, which would last only a short time.

Improvised Float Valve Causes Trouble

The pump was used to force water to a condenser tank on the roof of a four-story building. I went to the roof and examined the tank and the outlet of the pump line. Here, the cause of the trouble was easy to see, for the engineer had installed a sort of improvised float valve on the end of the pump line to shut off the water when the tank was full. His ingenious arrangement consisted of a quick-closing gate valve connected with a float on the end of a long rod. Whenever the tank filled with water, the valve would close with a bang.

It was certainly quick and positive in action, but the engineer had failed to take into consideration the resulting water hammer and overpressure on the pump and line. The sudden closing of this valve and the fact that water is incompressible, caused a terrific strain to be thrown upon the pump, consequently gaskets or packing would blow out or the heads or valve cover would give way.

The trouble was remedied by an automatic pump control, or governor, which closed the throttle when the pressure on the pump line exceeded a certain point. It was also necessary to replace the float valve on the tank with a type that would gradually shut off the supply.

I have seen somewhat similar trouble experienced with a large duplex house pump that supplied water to a couple of large roof tanks on the top of a twelve-story building. In this case there was a disagreeable pounding and thumping in the line, which annoyed the tenants of the building. This was also caused by water hammer. By the installation of a suitable pump governor, which would slacken the speed of the pump when the float valve closed, and by the addition of an air chamber on the end of the pump line to act as a cushion, the pounding was stopped.

Water Pressure Was Insufficient to Operate Valves

I once encountered an interesting water-pressure problem when the owner of a small hotel called me in to find the source of his perplexity. The hotel was a six-story building of about 160 rooms. Practically every room contained a bath and toilet. The owner explained that they were having a great deal of trouble with toilet valves, especially on the upper floors. It seemed that when the toilets were flushed the valves would remain open and continue to run, sometimes for hours at a time. The proprietor wisely figured that he was losing a great amount of water in this manner, and water means money. He further explained that upon some days and certain hours of the day the valves worked perfectly; again they would go "on the blink" at the same time. He said that a plumber had charged him $500 to install a large water tank on the roof which he claimed would eliminate the trouble. It had failed to do so, and consequently he was a bit prejudiced in his feelings concerning plumbers in general.

Nowadays an engineer is required to have a general knowledge of all the mechanical arts, and I had had quite a little experience as a plumber in hotels, therefore I decided to give the problem some thought. There were no box toilets in the building, all being equipped with modern diaphragm valves connected to a 1¼-in. water line. This type of valve is closed by the water pressure admitted through a small pinhole bypass. The valve remains open until sufficient water can pass through this small aperture to equalize the pressure and close the valve. They are designed to work under a certain water pressure, and if the pressure is too low they will refuse to function properly.

In this section of the city the water supply was inadequate. At times the pressure was very low on the city mains. The valves on the upper floors of the hotel gave more trouble than those on the lower floors for the simple reason that it required approximately fifty pounds pressure to lift the water to the sixth floor of the building, and there was no pump on the line. The plumber's tank on the roof had failed to relieve the trouble because the head of water was insufficient to produce the required pressure to operate the valves, a small motor-driven centrifugal pump was substituted in the basement and it supplied the desired pressure at all times.

Trouble with Fuel-Oil Pumps

I was once employed in a large Western power plant that contained a battery of oil-fired boilers. We experienced a great deal of annoyance with two small duplex pumps that were used to supply oil for the burners. These pumps were automatically controlled in the usual manner by a diaphragm governor. There is a state law that requires the fuel-oil supply tanks to be located a certain distance below the level of the engine-room floor; consequently the pumps were compelled to lift oil ten or fifteen feet, depending upon the amount of oil in the tank.

At times when the load was light and the amount of oil supplied to the burners correspondingly small, the pumps would move very slowly. Then if the foot valve on the end of the suction line happened to leak, the pumps would lose their suction and the fires would go out. This called for immediate action on the part of the engineer, for an oil-burning plant will not run long after the fires go out. Usually, it is a difficult job to get one of these small pumps to regain its suction after it is once lost.

We had two or three shutdowns in this plant on account of the fuel-oil pumps losing their suction. The trouble finally developed into a daily occurrence. I eventually decided that there must be something wrong with the pumps. I removed the valve cover on one of the pumps and examined the valves. They were found to be in good condition. Then I removed the heads on the pump end and examined the plungers, where I discovered the cause of the disturbance. Instead of plunger packing, the plungers were fitted with large lead rings that were supposed to act as packing. These rings had worn until they were very loose. With this arrangement the pumps could hardly be expected to lift oil any distance. I removed the lead rings and packed the

plungers with regular plunger packing, and the trouble was remedied.

Many Western power plants are finding it very difficult to secure a proper grade of fuel oil at anything like a reasonable price. The price of fuel oil has increased in the last few years, while the quality has deteriorated; we get oil of a heavy asphaltum base which contains sand and all kinds of foreign matter.

Burners and regulating equipment that were designed to handle the better grade of oil refuse to function properly with the poorer grade. An accessible and easily cleaned strainer should be a part of the oil fuel line to the burners. Some form of twin strainer is preferable for this service, as one strainer can be removed without interfering with the oil supply. Practically all modern types of burners contain minute openings which will clog with the slightest presence of foreign matter in the oil.

American High-Duty Ash Conveyor

A conveyor of the vacuum steam-jet type to handle high tonnages or to operate under unusually severe conditions has been perfected by the Conveyors Corporation of America, formerly known as the American Steam Conveyor Corporation, of Chicago. The new system operates on the same principle as the earlier types of steam-jet conveyor, but the pipe line intake tees and fittings are made up of semi-cylindrical sections bolted to a steel frame of parallel T-bars and angles. One section fits into another longitudinally through the use of a tongue and groove, and to give airtight construction the joints are cemented. At the joints between sections

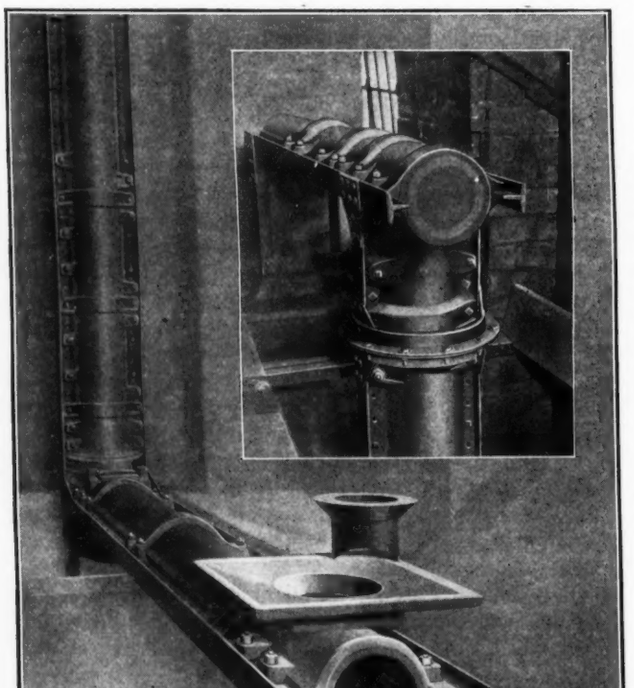


FIG. 1. A PORTION OF CONVEYOR LINE. INSERT, IMPACT ELBOW AT UPPER DISCHARGE RUN

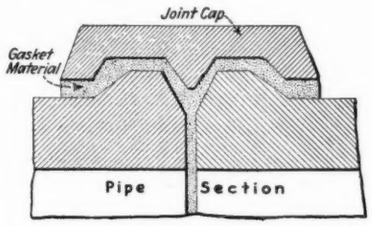


FIG. 2. JOINT CONSTRUCTION BETWEEN PIPE LENGTHS

lengths a cast-iron cap is bolted, and underneath it the cement or gasket material is squeezed into the crevices.

For the most part the sections are made in 2 and 4 ft. lengths, except where irregularly spaced ashpit doors make a variation from these standards necessary. When put in place, the half-sections are staggered with a view to equalizing the wear. The replacement of a worn section has been made so easy that no liners are employed. The metal is cast harder than it is possible to make full round pipes of the lengths formerly used. The frame takes the stress, so that it is not necessary to limit the hardness of the metal to secure the tensile strength that otherwise would be needed in the pipe line.

With the construction shown in the illustrations a straight pipe line is assured and there is no air leakage to reduce the capacity of the system. In Fig. 1, a portion of the conveyor line, may be seen the lugs provided for bolting each semi-cylindrical section of the pipe to the frame, the tongue and groove construction between sections and one of the intake tees. The insert shows the impact elbow. An important feature is the swivel allowing the upper horizontal run to be set in any direction. When a long overhead discharge line is necessary, the supporting structure is worked into a light truss carrying a walkway adjacent to the pipe line. This is intended to facilitate repairs to the upper line and to make the work safe. Fig. 2 shows the joint construction between lengths. The rib at the end of each section and the shape of the cap to conform with this design will be noticed.

The internal diameter of the pipe line is 9 in., and the diameter of the intake is 8 in.

A knock that apparently is in the piston pin of a Diesel engine is often a piston "slam" caused by excessive piston wear. At times this piston knock is caused by the connecting-rod bearings being out of line. A sharp metallic knock in the cylinder is usually the result of early fuel injection. This knock is produced by detonation and is termed "pinking." A dull knock or thump may be caused by a loose pin bearing or late fuel injection. At times it is caused by the piston striking the cylinder head—this applies to old-design Diesels where the clearance is very small at best. The piston rings should be cleaned every six months. If the top rings are gummed fast, strong lye will loosen them; kerosene and a brass scraper will do the work if the ring is not too tight. If a piston ring is broken, usually there is a click as the piston reaches the ends of the stroke.

EDITORIALS

The Federated American Engineering Societies

THE conduct of the Government of the United States involves the solution of engineering problems affecting the well being of millions of people and the expenditure of millions of dollars, but one may scan the roster of Congress in vain for the name of a prominent engineer.

Some time since, on account of the lack of participation in the affairs of the communities and the nation in those features with which the engineer is particularly familiar, the discontent of the rank and file of the engineering profession became articulate.

If the clergy or the legal profession were wiped off the slate, the world would go on much as usual; but without the engineer, industry, construction, transportation, all the complex material processes of modern civilization, would stop. And yet, ask the man beside you on the train for a list of the prominent people of his town and what do you get? Bankers, merchants, lawyers, doctors—but no engineers.

The engineer is tired of shifting the scenery and working the props back-stage to make the setting for another star. He wants to get out into the spotlight and have a speaking part and to feel that he is directly contributing to the common good.

Whether the organization of the American Association of Engineers was contributory to or the result of this state of unrest does not signify. Charged with inadequacy and inefficiency and lack of interest, the four great national professional societies appointed committees to consider how their activities could be extended. Representatives from these committees got together for conference upon their common problem, and the Joint Conference Committee was the result. Under its tutelage an attempt is being made to unite the professional engineering societies of the country in a movement which shall impress the collective wisdom and experience of the engineering profession upon public problems requiring technical skill and engineering analysis for their solution and put the engineer upon the map by giving him an opportunity for public service, and to have the public understand it.

A united profession, solidly organized and intelligently conducted, could accomplish wonders for the public and itself. In its hope for the latter there is nothing of unionism. The uplift is to be for the profession, broadly, and to carry the individual up with it, leaving him to manage the details of his own progress.

The movement was for solidarity in the profession, but a part of the outcome has been a schism. Some thirty-five per cent of engineers of the quality that was considered worthy of being invited have joined the movement; twenty per cent, in the Civils and the American Association of Engineers, have definitely determined to stay out of it; and the remainder, in the National associations of rather special character and numerous small locals, have not yet been able to consumate their membership or are waiting to see if the Federation succeeds instead of getting hold and making it a success. Furthermore, there is a schism in the Civils between those who would join and those who would not, those who are contented with and jealous of their professional standing and prestige and those who want to see the activities of the society broadened.

The American Association of Engineers is less exclusive. It is composed largely of the civil type of engineer, and includes in its membership and among its leaders many prominent members of that branch of the profession who are members of the A. S. C. E., but many also who would not be considered eligible to the older society. There is talk of a coalition between the Civils and the Association, the Civils to represent the high-toned technical end of civil engineering and to embody the preferment and recognition which come with achievement and success, the Association to take care of the so-called betterment work concerning more particularly the material condition and emolument of its members.

There are great possibilities of usefulness in the Federation. Under the inspiration and leadership of Herbert Hoover, with a united profession behind it, with means such as would be afforded by a contribution of a dollar or two per year from every professional engineer in the country, it could in a few years make the engineer a headliner in the drama of national life, impress his knowledge and analytical processes upon the problems with which the future has to deal, to their satisfactory solution and his everlasting credit. It is to be hoped that with a more general understanding of the purpose and methods of the Federation and with a realization of the fact that it is so well started that it is bound to be a success anyway, those who have viewed it with suspicion or disfavor will conclude to become a part of it, and make it a more immediate success and contribute their part toward making the engineering profession a factor in advancing civilization.

The Heating System As a Source of Power

IN POWER-PLANT practice there is no subject at the present writing more important than the conservation of fuel. The high prices emphasize the necessity of economy, and periodic shortages of coal make it obligatory to utilize fully all available sources of power. In the latter connection the article published on another page of this issue on "The Heating Plant as a Source of Power," is deserving of consideration. The plan of co-ordinating the power and heating functions so as to obtain maximum over-all results and to avoid duplication of equipment has possibilities that it would be well to investigate, particularly by large industrial heating plants buying current, and central district heating stations.

As the article states, the chief elements are the heating boilers, a forced-circulation hot-water heating system, with a turbo-generator exhausting into condenser heaters. The arbitrary control of the vacuum and terminal pressure effects a one-hundred per cent variation

in the steam rate of the power unit, as well as the temperature control of the circulating medium of the heating system. The salient features resulting from this arrangement are a variable power steam rate, constant power load recovery from the fluctuating steam requirements of the heating system, and temperature control of the heated spaces. It is evident that the heating system is modified to suit the characteristics of the condensing turbo-generator rather than the reverse.

This may be contrasted with previous practice of varying the power load with a constant power steam rate, as would be necessary with all systems of steam distribution. The variable steam rate enables nearly one hundred per cent more power to be recovered from the heating fuel. The maintenance of condensing conditions with minimum power steam rate when no heating is required eliminates the losses in summer attending non-condensing power generation.

Individually metering the quantity of heat to consumers would be unnecessary as increased consumption would be accompanied by additional power recovery. Low temperatures would govern the plant economy rather than quantity production. The equipment, however, lends itself to the employment at the source of meters and thermometers on water and current, so that accurate accounting could and should be established.

In the article the large plants illustrated offer a fertile field for improvement along these lines. Our inefficient household heating plants would afford another source of power that in the aggregate would permit of conservation on an immense scale. Efficient centralization of this heating within an economical radius could be effected by a central "block" plant equipped as previously outlined. The necessary requirements would be a load of sufficient size and a market for the recovered current. Over the wasteful apparatus and methods of the householder, the central plant would possess the advantage of the economies of centralized purchase and combustion of fuel aside from the salvaged commercial electric power.

There should be little question as to the ability of the central plant to show a good return on a heating charge equivalent to the cost of the domestic fuel where the householders' property is adequately heated. This would bring the advantages of central heating within the scope and income of most people.

Exhaustion of Our Oil Supply

A DEMAND echoed from practically every corner of the civilized world today is "More Power!" The reason for this is easily understood when it is realized that a reliable power supply has become as indispensable as food, water and heat. Power supply might be considered of even greater importance than the others, for our food, water and heat depend very largely upon the application of power. If modern civilization is to endure, it must have an abundance of cheap power. No wonder, then, that men of vision are giving so much attention to a power supply for the future. There are two important sources of power—fuel and water. The former is being rapidly used up. In fact, the exhaustion of some of our fuel resources is near at hand, while that of others is farther in the future. Our waterfalls, although limited in extent, are the only dependable source of power perpetuated by nature, therefore these should be used to the limit they are capable of serving. Already, natural gas, the ideal fuel, has been exhausted in a number of localities and is fast being depleted in other regions, so that today it is a mere incident in our industrial progress. Yet with the depletion of natural gas as a warning of how rapidly a fuel may be exhausted, we are attacking our oil reserves with ever-increasing vigor.

In this issue is published an abstract from a paper, "A World View of the Oil Supply," by George Otis Smith, Director, United States Geological Survey, in which he analyzes the oil situation in the world today, and suggests methods for its more economical use. How near we are approaching the exhaustion of our oil resources is shown by Mr. Smith in the statement that if the best steam practice of today is adopted as known in the largest central stations where fuel oil is used, the oil reserves of the United States are sufficient to supply our total power requirements for only approximately nine years. With the oil field of the United States perhaps forty per cent exhausted, we are still burning millions of barrels of oil in locomotives to haul trains over mountain grades, where there awaits development more than sufficient water power to operate these trains. Furthermore, hauling trains with electric locomotives supplied by power from hydro-electric stations is no longer an experiment, but is in actual practice on a large scale. In marine service a very large percentage of the oil used is burned under steam boilers, while the same quantity if utilized in internal-combustion engines of the Diesel type, would produce two and one-half times as much power.

During August and September our daily output was one and one-fourth million barrels and our consumption one and five-eighths millions barrels; that is, this country is today depending on outside sources for three-eighths of a million barrels of oil daily, and the ever mounting curve of consumption seems to know no limit. It is no longer a problem where to find a market for oil, but where to find the oil to supply the market. What are we going to do regarding our oil supply? Shall we wait until it is exhausted, as is the supply of natural gas, when it will be too late to act, or shall we join with the rest of the world in drawing up a world policy to safeguard the future.

The Council of the Federated American Engineering Societies negotiated its first breakers when it squelched an attempt to mitigate the stand taken by the organization congress for the fullest, freest publicity of all its acts and deliberations. Service to the public, which is urged as its leading motive, will thrive in the daylight and requires no sunshade. An unqualified declaration in favor of open covenants openly arrived at and a square deal with all the cards face up on the table will have a psychological effect in this formative and probative period which provision for no amount of imaginary and improbable contingencies could offset.

The selection of Washington as the headquarters of the newly organized Federated American Engineering Societies is a happy one. If the purpose were to impress the engineer on business, a commercial or industrial center would have had a prior claim. But the engineer is already impressed upon business. It is upon public affairs that he needs a chance to make himself heard, and Washington is the heart and pulse of the nation in this respect.

CORRESPONDENCE

Low Voltage Caused by Blown Fuse

Where the primaries of an electric-light line passed under a bridge, trouble by grounding and short-circuits interrupted the service to such an extent that it was deemed advisable to relocate the primary wires in order to avoid the cause. So an extension was built as shown in the figure. Beginning at point *A*, the line was run along a side street to point *B*, thence to point *C*, where a transformer was installed and the secondaries extended to *D*. The primary line from *A* to *D* was discontinued and the secondaries from No. 1 transformer were extended to *D*, and as the drop in voltage was excessive, the two secondaries were connected in parallel. This worked satisfactorily for a time, then trouble suddenly developed and the lights on transformer No. 3 dropped to about half candlepower and remained so. Linemen were sent out over the line to find the cause, but failed.

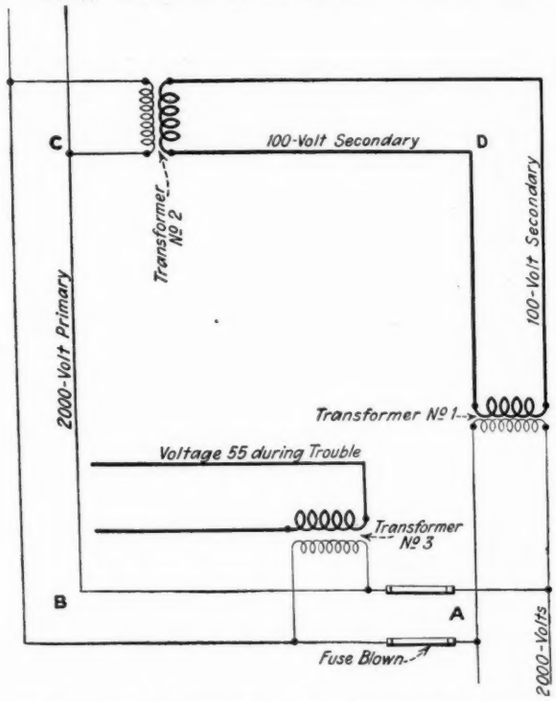


DIAGRAM OF PRIMARY AND SECONDARY CIRCUITS

The trouble continued for several days, and then someone suggested looking at the point *A*, where there were cutouts for the circuit recently installed. This was done, and one of the fuses was found blown. After a new fuse was put in, the lights came back to normal candlepower. It was then seen that when the fuse blew at *A*, the current followed the circuit from No. 1 transformer to No. 2 transformer, by way of *D*, through the secondaries. The current was then stepped up through No. 2 transformer and flowed to No. 3 transformer, where it was stepped down. The cause of the low voltage on transformer No. 3, after the fuse blew, was due principally to the line loss, as the distance from No. 1 to No. 3 transformer by way of No. 2 is about 4,000 feet.

LEON L. POLLARD.

Fairfield, Me.

Where Should the Beginner Start?

On page 711 of the Nov. 2 issue Mr. Winters, commenting on "Where Should the Beginner Start?" says: "About the poorest place for a man to learn to become a first-class fireman is in a stoker-fired plant."

The ordinary fireman in a hand-fired plant can, by wasteful methods, squander perhaps three or four tons a day if he is of very powerful build and the draft is good. Three tons of good coal wasted in one day of eight hours would be some work for one fireman. In a stoker-fired plant the same fireman could, in the same time, if he were so inclined, waste fifty tons of coal.

Sometimes the able fireman who can so thoroughly shovel coal into a furnace and hold the steam steady is worthless as a stoker man. In fact, I decided several years ago that I would rather take a boy off the farm and break him in on a stoker than to break in a hand-fired graduate.

Do not get the idea that a modern plant operates automatically and does not need a first-class fireman. The stoker plant needs the highest-class fireman if my experience has been worth anything.

For the benefit of Mr. Noble, whose letter appears on the same page, I would state that the pump that lost water at 30 ft. plus had one elbow in its suction line. This was of extra-long radius and the pump cylinder was only 6 ft. from the well. The brass lining was nearly new, and when water failed, a line was dropped in the well to determine draft. This well took water from a river which fell and caused the pump failure.

If Mr. Noble has a condenser and will make a connection to from 1-in. to 2-in. or larger pipe, he will be able to satisfy himself that a hole at the water line will serve to deliver a mixture of air and water to a surprising height. I heartily agree with him that a 27-ft. lift is mighty good.

C. W. PETERS.

New York City.

Mechanical Stokers and Their Operation

With reference to the article on "Mechanical Stokers and Their Operation," as published in the Sept. 7 issue of *Power*, and the letter of Mr. Riley in the Oct. 9 issue, I would state he is correct in his statement that in the description of the stokers shown, a single-retort type is referred to instead of the multiple-retort stoker.

We do not class the stoker illustrated in Fig. 4 of the original article as a gravity-feed multiple-retort stoker (as mentioned in Mr. Riley's letter), as *gravity* plays no part in its operation. The bottom of the retort is practically level, as will be noted by the illustration mentioned.

F. A. DEBOOS,
General Sales Manager,
The Under-Feed Stoker Co. of America.

Detroit, Mich.

Commutator Made from a Copper Block

The letter of H. E. Weightman in *Power* of Oct. 12, page 591, relating to a patent on making a commutator from a copper block, is very interesting inasmuch as the work described in the article referred to was done by myself while employed by the Sevenoaks Iron Works, England, in 1908, or eight years before the patent was issued.

VERNON PEARSON.

Macleod, Alberta, Canada.

[Mr. Weightman's letter says the method was patented in the United States in 1916 (No. 1,195,861). William J. Cummings states in the Nov. 2 issue that in 1900 the Eck Motor Works, Newark, N. J., made commutators from solid stock.—EDITOR.]

Records Tube Blowing and Blowoff Opening

In order to be sure that the boiler tubes are blown twice and the boiler blowoff valve is opened four times in twenty-four hours, I arranged a recording pressure gage as shown by Fig. 1, which records the events as they happen. The pipe line from the blowoff is ½ in. and gives full boiler pressure on the gage; the pipe from the flue blower is ¼ in. and does not show quite so high a pressure. Two check valves are used. One prevents the blowoff water from going into the tube blower, and the other prevents the steam from the tube bower from going into the blowoff line.

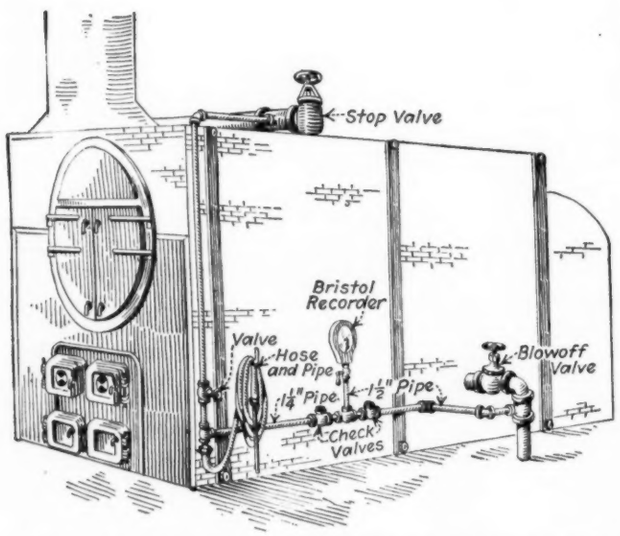


FIG. 1. ARRANGEMENT OF RECORDING PRESSURE GAGE

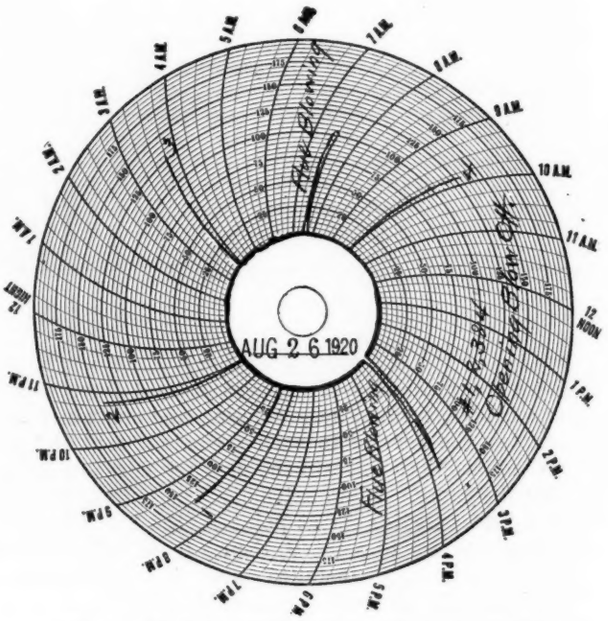


FIG. 2. CHART SHOWING BLOWING PERIODS

A sample chart showing the blowing periods is reproduced in Fig. 2.

JOHN T. SHARP, JR.
Canton, Miss.

How Can Shavings Be Burned with Coal?

Mr. Schatz's trouble with burning shavings and coal is caused by too much air blowing in with the shavings going into furnace, thus producing a blast effect upon the boiler. In a certain planing mill where the ashpit doors were closed and the cyclone discharged dust only into the furnace with a strong blast, it actually burned up an entire set of grates, the blast being downward.

It is inferred that Mr. Schatz blows his shavings through the front of the furnace, which causes a blast against the boiler with the effect complained of. The cyclone in his case is too small for the service required else the air outlet is choked, thus causing too strong a blast into the furnace.

Feeding the shavings into the furnace is the correct method, but it should not have more than a natural draft equivalent of the blast discharging into the furnace with the shavings, as too much blast or draft will cause a waste of unburned fuel to pass out through the stack.

If it is not desired to burn the shavings direct from the cyclone, then the best method is to bed the coal on top of a layer of shavings at each interval of firing. This method seems to work satisfactorily when not enough of one kind of fuel is on hand.

The requirements of each individual plant must govern the amount and interval of firing.

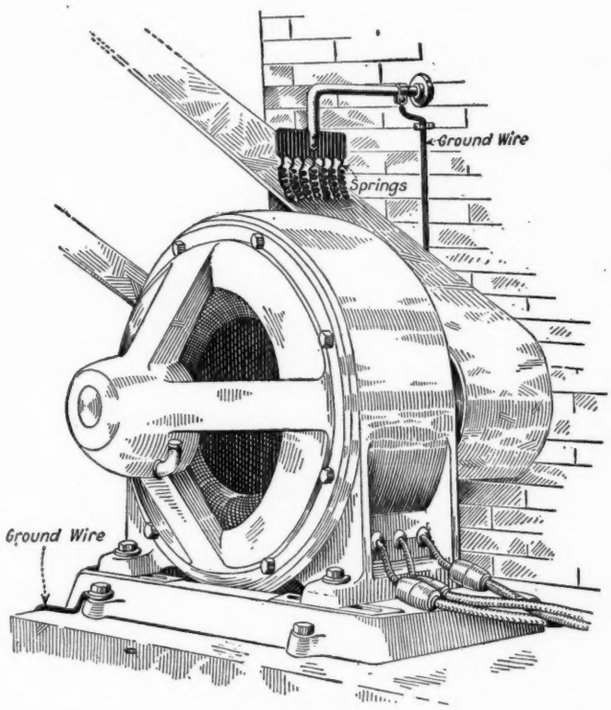
E. G. HOPPE.

Cairo, Ill.

Static Electricity in Belts

On page 631 of the Oct. 19 issue, B. A. Briggs asks for information relative to static electricity. I have had considerable experience with static and static-electricity troubles, having been connected with the electrical department of a textile plant for a number of years. A few years ago we had a 15-hp. motor that was connected to a lineshaft driving a group of braiding benches and located on a platform suspended from a wooden ceiling. The frame of the motor was not grounded, the only electrical connection being that of the leads.

Trouble was reported with the motor and was immediately looked into. Flashing was observed between stator and rotor at intervals of from four to ten minutes



DEVICE INSTALLED TO REMOVE STATIC ELECTRICITY FROM BELT

and was very vicious on dry days. The motor was tested for short-circuits, open-circuits, grounds, etc., and in all cases tested clear. The insulation was charred on the stator where the flashing occurred, but did not seem very deep. As soon as the motor was started up, flashing occurred at regular intervals, and before an opportunity was given to do something to remedy the troubles, the motor burned out. A spare motor was immediately substituted and operated for a short time, when the flashing occurred again. By this time the other motor had been rewound, and it was replaced in its original position. But this did not improve matters; the flashing reappeared, and I was given the job to locate the trouble. The motor tested free as before, but I observed that it was highly charged with static electricity when running, so I decided to ground its frame. As soon as this was done, the flashing ceased. I immediately proceeded to devise means of arresting the static from the belt, which was done by installing a comb made from a sheet of copper with fine springs soldered to its teeth, as shown in the figure. These fine springs were allowed to touch the belt, as they did not injure it. The trouble never appeared again, and it seems evident to me that the static charge would build up in the rotor until it jumped the air gap to the stator and traveled along the power circuit through the ground detector to the ground.

We now make it a part of the installation of each motor where it is belt-connected, at the first indications of static, to install one of these static arresters, and no further trouble has been experienced. When any machine, motor or belt is troubled with static charges, ground the frame of the machine permanently and effectively, making sure that the ground is a good one, such as a water pipe and that all the connections are clean, also ground the belt in the manner explained, and my experience shows that the trouble will disappear. In some places humidifying apparatus has been installed. This is helpful and in several cases has eliminated static charges, but where there is no such apparatus grounding the affected parts generally proved to be the remedy.

Ansonia, Conn. WILLIAM T. ESTLICK.

B. A. Briggs asks about static electricity. A case of trouble worked out some years ago comes to mind and will perhaps be worth something to your readers.

While acting as construction superintendent for an elevator company, I was called one night to repair a passenger elevator which had been installed only a few days. The control board was found alive with static and the small fuse on the control circuit blown out. It was replaced and a little later the same thing happened again. A close inspection showed that the slack-cable device contacts were burned by an arc. These contacts were well insulated and were about one-half inch from the metal box inclosing them, which was thoroughly grounded.

Having found evidences of heavy static charges on other elevators in the same city, I asked the chief electrician about conditions at the plant. It was found that they had belted generators and that they had just rebuilt the power line uptown, so it was well insulated. We had the engineers install a metal comb within a half-inch of the belts (the best place is on the tight side of the belt as close to generator pulley as possible) and ground this comb. This stopped all our trouble and, I think, proved my theory to be right as to the cause of trouble, the theory being that the static jumped to the grounded metal box after which the 500-volt current held an arc till the 15-ampere fuse blew out in the control circuit. If the insulation of the power line had been poor, the static charges would have leaked to ground along the line.

I would consider static as being more or less of a menace to motors and generators. It is easily eliminated, and this should be done in my opinion.

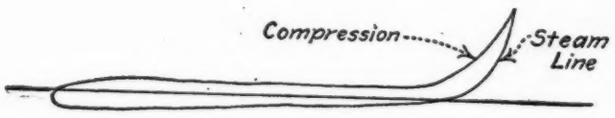
Snyder, Tex. D. P. YODER.

In answer to B. A. Briggs I would say that the static charges established on motor belts would not affect the efficient operation of electric motors. Of course there is the objection of slightly shocking persons coming near such belts and in contact with the machine, especially if it is ungrounded. Experience has shown that static charges from such belts may accumulate to the extent as to break down the insulation of motors or generators. To prevent such charges, a grounded metal comb should be installed, close to the belts.

Linton, Ind. JOHN R. LUXTON.

Indicator Test Diagrams

On page 515 of the Sept. 28 issue, G. B. Longstreet presents some indicator diagrams that were taken to show that his engine does not leak. Although these diagrams are interesting, it is my opinion that they do not prove non-leaking valves. I had this impression some years ago, and having a 250-hp. engine, I took the diagram shown, immediately after tripping the ball clutch to let the valve rod telescope. This, it will be



MR. WALDRON'S TEST DIAGRAM

understood, closes both steam valves, shutting down the engine without closing the throttle valve, which practically will give the results Mr. Longstreet gets.

But my engine did leak, both in the steam and in the exhaust valves and also the piston. It was 23 years old and had never had anything done to it during that time. No doubt a similar diagram would look much different now. We have all heard the statement, especially in regard to compression, that the object compressed will give out all it takes to compress it. While this is true of a steel spring, it is not true of steam compression.

In considering Mr. Longstreet's second diagram of Fig. 1, where *B* is the compression curve which runs up while the engine is passing the center, what made the curve *C* depart from *B* while coming down? Is this leakage or condensation or a little of both? If condensation, why did not re-evaporation do better and make *C* go back nearer the line *B*, since but a second before the same cylinder had a temperature far in excess of that due to the compression line *B*?

I believe condensation is responsible for the most of this difference between *B* and *C*, and the best test I know of is to take off the head and see if steam comes through the steam valve or indicator pipe on the crank end. For the exhaust with the head on, disconnect the exhaust pipe; for piston leakage I block the crosshead and admit steam. I am glad to see these freak cards and hope others will also experiment, as it shows a progressive mind.

A. WALDRON.

Malden, Mass.

Socketing Hoisting Cables

Referring to the article in *Power*, Sept. 21, covering experiences with cable sockets, I wish to add the following:

At a certain mine shaft two failures of cables at sockets caused the wrecking of both cages each time, but fortunately, as coal was being hoisted, no loss of life resulted. The failures occurred about seven months after cables were resocketed, and the mine was operating at less than half capacity; the number of trips made by the hoist were less than 50 per cent of what was normal for that period.

In making a careful survey of conditions it was discovered that the head sheaves were loose on their shafts. Having about ☆ in. larger bore than the diameter of the shaft, these sheaves were keyed to the shaft with a feather key and as they revolved they would hang (so to speak) on the key until the latter was nearly on top of the shaft, when the sheave would drop, which gave a severe jerk to the cables and set up vibration and unusual strains with the results mentioned. Refitting the sheaves with new shafts pressed on tight stopped any further breakage of cables at the sockets.

Regarding the use of zinc for fitting sockets, I find it is best to clean each wire with sandpaper, before immersing in the muriatic acid, then each is certain to be well galvanized and will take its share of the load. The usual instructions for doing this work are rather loose regarding the cleaning of the wires. Anyone who has had experience in soldering knows how essential it is to have the work scrupulously clean. To properly prepare and pour a socket on a 1⅛- or 1¼-in. cable requires not less than five to six hours.

Just previous to pouring the zinc in a socket, I preheat it to a temperature of 400 or 500 deg., then slip the socket over the wires, then quickly seal around the cable and pour the zinc, being sure that it is hot enough.

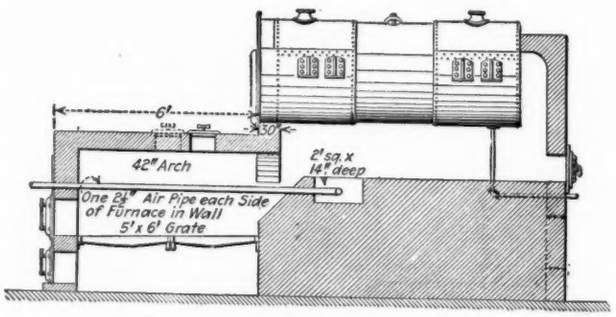
W. F. SHUTT.

Dolores, Tex.

Trouble in Burning Hog Fuel

The following may help C. W. Fields, who is having trouble burning hog fuel. The clinkers that form on the grates are caused by the grit on the logs which is carried into the furnace with the sawdust. The furnace nearest the mill or the one that gets the fuel first will generally have the most clinkers.

His feed hole should be set six inches nearer the boilers, as shown in exaggerated form in the illustra-



MR. FIELDS' FURNACE IMPROVED

tion; then the front end of the grates would get the fuel first, and that would save tamping and leave the end next the firedoors open. There is too much combustion area behind the bridge wall. As there is not as much carbon in hog fuel as there is in coal, the combustion chamber should be cut down. The cleaning-out door in the rear should be raised above the blow-off pipe as shown, and the grates should be of the crown type for burning sawdust; then they will be fairly clean at the end of a ten-hour run.

We are operating a battery of boilers equipped in this way and they are doing fine work. The sketch shows the area of the combustion space that should be filled in.

G. L. BALDWIN.

Millsite, Vt.

INQUIRIES OF GENERAL INTEREST

Alternate Firing More Economical—In firing four 300-hp. vertical boilers each equipped with two firing doors, with two firemen to a watch, is it better to fire each boiler through both doors at the same time or to have one man firing one side of one boiler and the other firing one side of another boiler? R. J. N.

If the firing is performed quickly, leaving the firedoor open as short time as possible, greater perfection of combustion can be secured and better coal economy by firing alternately with equal intervals of time; that is, first at one door and then at the other, thereby making the stoking more nearly continuous.

Steam Pistons of Duplex Pump Cushion on Exhaust—What prevents the pistons of a duplex pump from striking the cylinder heads at the ends of the strokes? R. M.

Before either steam piston reaches the end of a stroke it passes over and closes the opening of the passage for escape of the exhaust that is ahead of the piston. Any exhaust steam thus trapped in the cylinder between the piston and cylinder head, or that may fill the separate steam passage from the cylinder back to the steam valve, becomes compressed by further motion of the piston and acts like a cushion for gradually arresting the motion of the piston and prevents the piston from striking the end of the cylinder.

Removing Scale From Water-Tube Boiler—What treatment can be employed for removing lime scale from a water-tube boiler used for heating? J. A. B.

Add to the boiler water about one-fourth pound of soda ash or caustic soda per rated horsepower. Then carry only enough fire to hold about 10 lb. gage pressure for 48 hours and blow off the boiler when the setting has cooled down. The soda should soften up the deposit so it can be washed out with a hose. Two or three such boilings and washings might be necessary. After the final boiling the boiler and fitting and connections, especially the safety valve, should be thoroughly washed clean of all traces of the soda and special care should be taken to wash out the mud drum. If the soda boiling will not remove the scale from the tubes it may be necessary to clean them by the use of a mechanical tube cleaner.

Attention to Bagging of Boiler—Is it objectionable to continue firing a horizontal return-tubular boiler that has a slight bag in the shell over the fire? W. H. F.

A bag usually is produced from a deposit of oil or scale which prevents the shell from being kept cool by the water in the boiler, and the material of the shell becomes more or less burnt. A depression of the kind, once formed, becomes a pocket for gathering deposits of non-conducting substances followed by greater overheating and more bulging and thinning out the plate from internal pressure, which is likely to develop rupture without notice. Hence, a bag should be repaired at the earliest opportunity, by bumping the bag back if the bulging is so little that bumping-back is practicable, or if bumping-back cannot be performed, the bag should be cut out and the boiler shell should be properly patched from the inside and thereafter used with a reduction of pressure, the amount of reduction depending on the condition of the material and character of the patch.

Providing Injector Capacity—Why should a new injector be provided with capacity for delivery of more water than the rated evaporative capacity of a boiler? W. E. G.

The working capacity of the injector should be at least double the rated evaporative capacity of the boiler to cover emergencies of low water from accidental leakage, blowing off and oversight of attendance, as well as the evaporative requirements when the boiler is forced to its highest possible capacity, which in many plants exceeds 75 per cent beyond the rated capacity. To insure the proper working capacity after the injector has become worn, clogged with scale or otherwise impaired from use, the injector's capacity when new should be two and one half to three times the rated evaporative capacity of the boiler.

Speed of Direct-Current Motor—Why will a direct-current motor accelerate in speed when its field current is decreased and be retarded in speed upon increasing the field current? W. M.

The speed of direct-current motors is controlled by their counter-electromotive force. The armature current is equal to the applied voltage minus the counter-electromotive force, divided by the armature resistance. This may be written:

$$\textit{Armature current} = \frac{\textit{applied voltage} - \textit{counter-emf.}}{\textit{armature resistance}}$$

The counter-electromotive force is proportional to the field flux, multiplied by the speed; that is

$$e \propto N \times S$$

where e is the counter emf. which varies as N the flux times S the speed. Consequently if N is increased by increasing the field current, S must decrease if e is to remain the same, and vice versa.

Advantages of Superheating Steam for Turbine—What percentage of saving is superheated steam to a steam turbine; for instance, what is the saving from superheating dry saturated steam at 150 lb. gage, 366 deg. F., to a temperature 50 to 60 deg. higher? H. G. D.

Manufacturers of steam turbines usually furnish a statement or a set of curves based upon actual tests showing the amount that the steam consumption per kilowatt-hour will be increased or diminished by stated variations from standard conditions, as the economy of any steam turbine is greatly influenced by the conditions of pressure and vacuum as well as quality of the steam. In high-pressure turbines the steam consumption is improved approximately 1 per cent for every 7 to 13 deg. superheat, the better value holding good for about 50 deg. superheat while the lower value holds good for about 200 deg. superheat. Hence, for 50 deg. superheat the steam consumption would be about 7 per cent less and for 60 deg. superheat the consumption would be reduced about 8½ per cent below that for dry saturated steam. The actual plant saving would depend on the additional cost of increasing the degrees of superheat.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

A World View of the Oil Supply*

By GEORGE OTIS SMITH
Director, United States Geological Survey

THE world needs more power. The central theme of modern history has been man's increasing use of mechanical power. Yet it remains for the world to be motor-driven to the degree that would balance the need of humanity for increased productivity. The economic law of this power demand is tersely expressed in an editorial heading in a recent issue of the technical journal *Power*—"Horse Power per Man Power Is a Measure of Modernism."

One of the byproducts of the co-operative efforts by the Government scientific bureaus in the aid of our Peace Commission was an inventory of the water-power resources of the world, and this is now being prepared for publication by the United States Geological Survey. It shows that only about one-twentieth of the potential power of the world's rivers has been utilized, and over half of this in North America, with Europe credited with one-third and the rest divided between Asia, South America, Oceanica and Africa, in the order named. In its potential resources, however, Africa ranks not last, but first; it has over 40 per cent of the world's supply of water power and is followed in turn by Asia, North America, South America, Europe and Oceanica.

Distribution of World's Coal and Oil Reserves

In the division of coal resources among the continents, at least of the better grades of coal, similar inequalities are seen. North America has more than half, Asia about a quarter, Europe a sixth, and the rest is divided between Oceanica, Africa and South America in the order named. Accepting the Stebinger-White distribution of the world's oil reserves, we may roughly set down the continents in order of wealth in oil as North America, Asia, South America, Europe, Oceanica and Africa.

The resources of the world's oil shale are far too large to be lost sight of as a substitute source of oil. The United States alone is believed to possess deposits of oil shale that contain at least ten times as much oil as there is natural petroleum available in North America, but oil won by mining and distilling these shales, situated in the interior of a continent, cannot enter the world's markets as labor-cheap as the petroleum that flows from Mexican wells close to the coast.

In this rapid review of the world's sources of energy we see North America taking first rank among the continents, with Asia a close second and Europe a poor third, although we should remember that Europe has a much smaller area than either of the other two.

Differences in the Three Great Sources of Energy—Water, Coal and Oil

Now, in considering how the world may best manage its ever-increasing power load, some aid may be found in a few comments on the differences between these three sources of energy—water, coal and oil. Man has learned how to harness flowing water with great efficiency, but even in Europe and North America only about one-fifth of the potential power has yet been developed. But we may expect our rivers to take on an even larger share of the base load in any power program that seeks to conserve the energy supplies in coal, oil and men. Of course, even with wisest utilization, coal must again take up the burden as full development of water power is approached, for coal is the world's great source of heat and power, and the largest development of water powers is practicable only with coal power as the dependable "stand-by," ever ready to meet promptly any special demand.

Oil and natural gas are the popular fuels, regarded as highly efficient because they are preëminently labor saving—easily produced, easily transported and easily used. As a source of power these fluid fuels present a marked contrast with water. Hydro-electric energy is even more easily distributed and used, but water-power development involves large capital outlay and in any national emergency no quick response in water power is possible; the water-power projects planned to meet the power needs discovered in the course of our wartime expansion of industry are even now hardly under way. But when the large necessary investment of labor and material is once made in water power, the output of energy continues for generations. Oil and gas, on the contrary, are quickly developed and quickly exhausted. Already we realize that natural gas, the ideal fuel, is a resource so temporary that its use forms merely an incident in industrial progress; it has been a wasted as well as a wasting resource. The sorry lesson we have learned in natural gas may have its value if we apply the truth to our use of oil. Unless we check the increase in the consumption of oil it, too, will be but a flash in the pan.

Relative Positions of Water, Coal and Oil

If we leave the world point of view for a moment and look at the power problem in our own country, we are able to see in more detail the relative position of water, coal and oil as sources of energy. To compare these three resources, we may start with the country's present total power requirements. If we take 50 million horsepower as an average figure for the potential water power of the United States, without storage, we find that if fully developed and if used at the average load factor of today our rivers and streams would just about meet the country's present needs and would supply that amount of power for all time; moreover, with storage and an improved load factor they could provide a considerably increased output of energy to meet the growing demand.

If, however, we should put the whole burden on our coal mines, not using even the water power now used, we would find that by adopting the best steam practice of today the present power requirements of this country could be met with coal for 57,000 years.

Adopting the best steam practice of today as known in the largest public-utility stations where fuel oil is used and trying to carry the whole power load of the country with oil alone, we find that the oil reserves of the United States, although measured by billions of barrels, would last only 9¼ years. Without allowing for the fact that steam-raising for power is but one of the many uses of coal, these two figures —57,000 years and 9¼ years—are sufficiently impressive to make us fairly receptive to the general truth of Mr. Eckel's statement in his recent book "Coal, Iron and War": "We have just as much real chance of replacing coal by oil as we have of finding enough gold to use it in place of steel."

Priority in Use of Oil

Granted, then, that we have not enough oil to permit its use where either coal or water power can be had, we face the question of priority in use. In view of the rapid increase in the employment of machinery first thought should be given to the unique function of oil—that of saving power. The world will always need a supply of lubricants, and as the demand will be an increasing one no adequate substitute for the lubricating oils and greases now derived from petroleum appears to be available. The claim of illumination for priority is less well established if we regard the future, for the kerosene lamp and even the fixtures burning oil gas or enriched water gas must eventually give place to the electric light.

The real competition comes in the relative claims of automotive gasoline and of fuel oil, for the larger yield of gasoline through more efficient cracking is gained at the expense of the fuel-oil content of the crude oil. This is conclusively shown in the statistics collected by the Bureau of Mines, for in the last four years the fairly constant gain in the percentage of gasoline yield is offset by a similar loss in the yield of fuel oil and gas oil. These two uses are to

*Abstract from a paper presented before the American Petroleum Institute, Washington, D. C., Nov. 17, 1920.

that extent already rivals, and we may expect refinery practice to be responsive to the automatic control of prices, which in turn ought to express relative demand. A logical plea for motor fuel can be made by the trucks that already form so large a part of our distribution system and the tractors that by the million will soon be helping to meet the world's increased demand for food. Truck and tractor must be given the first places in the long line of automobiles seeking motive power at the gasoline station.

Fuel oil has won favor as a source of power for transportation because it has been relatively cheap, is easier to handle and occupies less space than the equivalent heat units in the form of coal. In these respects fuel oil is superior for use in transportation, and this use deserves priority over that for firing stationary boilers, for which coal should be substituted. Indeed, thoughtful regard for the future leads us to disallow even the claim of steam locomotives for fuel oil, for electrification of the railroads by water power alone or from water-power stations and steam stations linked together is now the obvious way to make the best use of our resources of expendible fuel. Austria, bankrupt in fuel, having lost her coal and oil, has begun to electrify half her railway mileage. Shall other nations wait until they, too, are bankrupt in oil before awaking to the need of change in sources of power? The program of conservation through electrification has started, and while this simply emphasizes our future dependence in larger measure upon coal, it should at once make us abandon fuel oil as a source of motive power for our railroads and industries. In a word, the world has not oil enough to burn under either stationary or locomotive boilers.

Advantages of Diesel Engines in Marine Service

The very facts that support the argument for the marine use of fuel oil—greater efficiency and economy of space and labor—can be cited in favor of the internal-combustion engine of the Diesel type as against the steam engine. The increased thermal efficiency of the new engine with its resulting addition to available cargo space or to cruising radius, is more than 2½ times that of the steam engine. The experience of the Bethlehem Steel Co. is that their new oil-engine ore-carrier, the "Cubore," in continuous service between Cuba and Sparrows Point, Md., uses only 36.7 per cent of the fuel oil consumed by a sister ship, differing only in that it has the most modern type of steam plant. The tremendous economy thus possible in the marine consumption of fuel oil demands the immediate adoption of internal-combustion engines if the world wants to make the largest use of its oil resources for the longest time.

How to supply the world's needs in oil thus comes to be an international question of the first order. Our monthly statistics take on the importance of danger signals, which must be read "Run slow." Perhaps these figures can be best grasped if they are stated in terms of a daily balance sheet. In September of this year, as in August, the daily output of the United States oil wells was slightly over 1¼ million barrels, but the daily consumption rose to 1⅝ million barrels. This daily deficit of three-eighths of a million barrels was met by imports from Mexico. In meeting the world's need for oil, the United States has played a large part. In the last sixty years our contribution to the world's output of oil has been never less than 44 per cent (the figure during the brief period when Russia led) and earlier reached even 99 per cent, while of the total 8 billion barrels so far consumed by the world 5 billions came from the wells of the United States.

Dangerous Rate of Increase in Oil Industry

With the oil fields of the United States perhaps 40 per cent exhausted, it is not reasonable to assume that 60 per cent of the world's output will continue to come from wells in the United States. It is true that no other primary industry has shown anything like the growth of our oil industry, and even now the dangerous rate of increase continues; for the normal output of most commodities we can take the year 1913 as an index, but our output of petroleum in 1920 promises to exceed that of 1913 by nearly 75 per cent, and we may add that our output of gasoline has shown almost an equal increase in half that time. We who have watched this marvelous growth of the oil industry have seen within a few years the transition from oversupply to overdemand, and the ever-mounting curve of consumption seems to know no law.

A world policy, if it is to safeguard the future, must draw up a program that will favor thrift in the use of the oil currently produced, and in that program also there must be a joining of the nations in continued effort for the common good. When the world runs short of oil, all nations will suffer, regardless of the geographic location of the remaining wells. America has led in teaching the world to use petroleum, whether in lamp or automobile or tractor, and it should be America's special duty to teach the world to use petroleum most efficiently. No longer is there any need to make a market for oil; the task is to find the oil to supply the demand already created.

The substitution of fuel oil for coal has had no noticeable effect on the consumption of coal, although it has materially increased the consumption of oil. Thus in the industrial zone between Washington and Boston, fortunately, little fuel oil is used by the public-utility electric plants, the quantity even now being equivalent to less than 2 per cent of the coal used, yet it is significant that this use has more than quadrupled since January of this year. An authoritative statement, moreover, can be made that over the country as a whole this competition by fuel oil, generally referred to as the "fuel-oil menace," has had but little effect on the demand for coal. Two inquiries were made in 1919 and 1920 by the United States Geological Survey to ascertain the stocks of coal held by the electric utilities and general industrial plants, and incidentally any change in the fuel used was reported. The substitution of oil for coal in the year ended March 1, 1920, as indicated by these reports, affected about 3 per cent of the plants, but represented only about 1 per cent of the coal consumption. This substitution was confined to the seaboard and to localities close to the oil fields. In short, fuel oil is not a competitor to be feared by coal, and its use under stationary boilers is a menace only to the higher use of fuel oil or some other product of petroleum.

Necessity of Economy in Transportation of Oil

Economy in the transportation of oil is a topic that especially deserves the world view. As in the interstate traffic in coal, so in the world commerce in oil, cross-hauls are to be avoided. Economy on a large scale demands that the oil come from sources as near at hand as possible. The conception of American tankers encircling the world with cargoes of Texas fuel is more picturesque than practical if other and nearer supplies are available. The Western and Eastern Hemispheres should be as independent as possible, for it is indefensible waste to burn oil to carry oil across the Atlantic or the Pacific in both directions. The ideal plan for fuel-oil bunkering will provide well-distributed stations, backed up with near-by reserves of oil, and such a system seems to be an essential part of any shipping program, whatever the flag of the oil-burning ship. This type of thrift in oil would mean foreign supplies of oil with which to bunker American ships.

With five-sixths of the world output of oil coming from the Western Hemisphere, however, it is too soon to expect the economy in the transportation of oil that has here been suggested, yet it is not too much to seek to make the rest of the world more self-supporting in oil and less of a drain upon the Caribbean region. A kind of oil-zoning system for the world may some day not be too extreme a proposal if we are to give full force to plans for economy in oil. So, too, a question that may sometime be asked is whether national or international oil-bunker stations are better justified.

Brazil has extensive plans for the development of interior transportation, including the construction of power plants for industries and the electrification of railways. Rio de Janeiro is to have a 270,000-hp. plant erected in the near future by an internationally organized company having American interests, according to Dr. Julius Klein, United States Commercial Attaché to Buenos Aires. Two hydro-electric stations are to be built and an electric street-car service inaugurated in the vicinity of Rio de Janeiro.

The Federated American Engineering Societies

Holds Its First Meeting—Herbert Hoover Elected President—Conditions of Labor and Production Discussed

THE first meeting of the American Engineering Council of the Federated American Engineering Societies was held at the New Willard Hotel, Washington, on Thursday and Friday, Nov. 18 and 19. In his opening address Richard L. Humphrey, chairman of the Joint Conference Committee of the four founder societies under whose tutelage the Federation has been brought about, said that the committee had kept in active touch with the 116 organizations invited and had received replies from all but about 3 per cent of the aggregate membership represented by them. Organizations represenative of 35 per cent of this aggregate membership had accepted the invitation, and including participating organizations which are still giving the matter of joining favorable consideration but have not taken final acton, 50 per cent of the aggregate is represented at this meeting.

The unanimity of desire of the engineering and allied technical professions for a comprehensive organization that can speak for them in matters of public welfare, where technical training and engineering experience are involved, as well as in matters of common concern to these professions, culminated in the unanimous creation of the Federated American Engineering Societies and of its governing board, American Engineering Council, and has attracted world-wide interest. There has been a fear among the members of some of the societies invited to membership that this organization will become a political machine and will indulge in lobbying and pernicious practices in the promotion of causes favoring special interests, and not for the general good of the profession. In all the meetings of its organizers this is not one of the matters on which there has been a division of opinion. The organization was not formed for a purpose inimical to its success.

The Federation Not a Labor Union

The organization has also been characterized as a labor union. This is distinctly what it is not. Engineering Council has undertaken the preparation of a schedule of classification and minimum compensation for engineers in various lines of work, and it is expected that this work will be continued by American Engineering Council. If this schedule is backed by this representative party, it will effectively establish standards which will be instrumental in raising the minimum compensation of engineers. It is assumed that it will not be the function of this body to enforce the minimum compensation, since this will be left to the individual. This marks the important distinction between the functions of this body and those of a labor union.

There is an opportunity now to render a great nation-wide service by the establishment of an Engineering Societies' Service Bureau, furnishing a point of contact for engineers desiring employment and those who desire to employ engineering service, and having in every city branches that will exert a great co-ordinating influence over the profession and industry. The vital need for constructive suggestions, based upon careful study of the great national problems, such as transportation, conservation of labor, water, fuel and other natural resources, should be met through the work of this organization. Such methods are especially within its field, and it should devote its energies to helpful work in this direction as far as the non-technical phases are concerned.

The securing of a National Department of Public Works, of assisting in many problems connected with the National Budget System, are among the important phases of desirable activity for this organization.

It is earnestly desired that this body shall not dissipate its powers in work on unimportant details, but show a capacity for leadership, forming public opinion by bending its energies to those problems which involve technical training and engineering experience.

In conclusion he said: "The first step in realizing the dream of the engineering and allied technical professions for solidarity has been taken. The wisdom of your acts will be reflected in a measure of success which shall result in increased support from the engineering and allied technical organizations. If you live up to your best, no organization will wish to be outside the pale of membership. The keynote of whatever policy you may agree upon should be service."

E. S. Carman, of Cleveland, Ohio, president-elect of the American Society of Mechanical Engineers, was elected temporary chairman, and William E. Rolfe, representing the Associated Engineering Societies of St. Louis, temporary secretary.

Owing to the decision of the American Society of Civil Engineers, which society he represented on the Joint Conference Committee, not to participate in the Federation, Mr. Humphrey was without official standing in this meeting. The body, however, voted its appreciation of his past efforts, its regret at the circumstances which prevented his being present as a representative, and extended to him the privilege of the floor.

Following the appointment of temporary committees on program, credentials, constitution and bylaws, nominations, plan and scope, budget and resolutions, a discussion regarding the place of meeting came up, and the question was undecided at the noontime adjournment.

Headquarters To Be in Washington

In the afternoon J. Parke Channing gave an address reviewing the work of Engineering Council, of which he is chairman. This was followed by a discussion of the Field of Activity for the Federated American Engineering Societies, after which the discussion upon the location of the headquarters of the American Engineering Council was resumed and resulted in the choice of Washington. The afternoon's activities concluded with an address by Lewis B. Stillwell, of New York, upon Transportation.

On Friday morning, pending the report of the Committee on Nominations, L. W. Wallace, of Baltimore, addressed the council on the Conservation of Labor.

The Committee on Nominations suggested the following list of officers, who were unanimously elected: President, Herbert Hoover; vice-presidents, Calvert Townley, of New York; William E. Rolfe, of St. Louis; Dexter S. Kimball, of Ithaca, and J. Parke Channing, of New York; treasurer, L. W. Wallace, of Baltimore.

The council avoided its first rock when, in the discussion of the report of the Committee on Constitution and Bylaws an effort was made to modify the declaration adopted by the organizing conference that the proceedings of the council, executive and other committees, and the records thereof should be available to the public and the press. After a rather lively discussion the provision for open covenants openly arrived at was allowed to stand.

Address of Herbert Hoover

In the evening a meeting to which the public had been invited filled the ballroom of the New Willard. The feature of the program was an address of the newly elected president, Herbert Hoover, in the course of which he said:

Enormous industrial expansion of the last fifty years has lifted the standard of living and comfort beyond any dream of our forefathers. Our economic system under which it has been accomplished has given stimulation to invention, to enterprise, to individual improvement of the highest order, yet it presents a series of human and social difficulties to the solution of which we are groping. The congestion of population is producing subnormal conditions of life. The vast repetitive operations are dulling the human mind. The intermittency of employment due to the

bad co-ordination of industry, the great waves of unemployment in the ebb and flow of economic tides, produce infinite wastes and great suffering. Our business enterprises have become so large and complex that the old personal relationship between employer and worker has to a great extent disappeared. The aggregation of great wealth, with its power of economic domination, presents social, economic ills which we are constantly struggling to remedy.

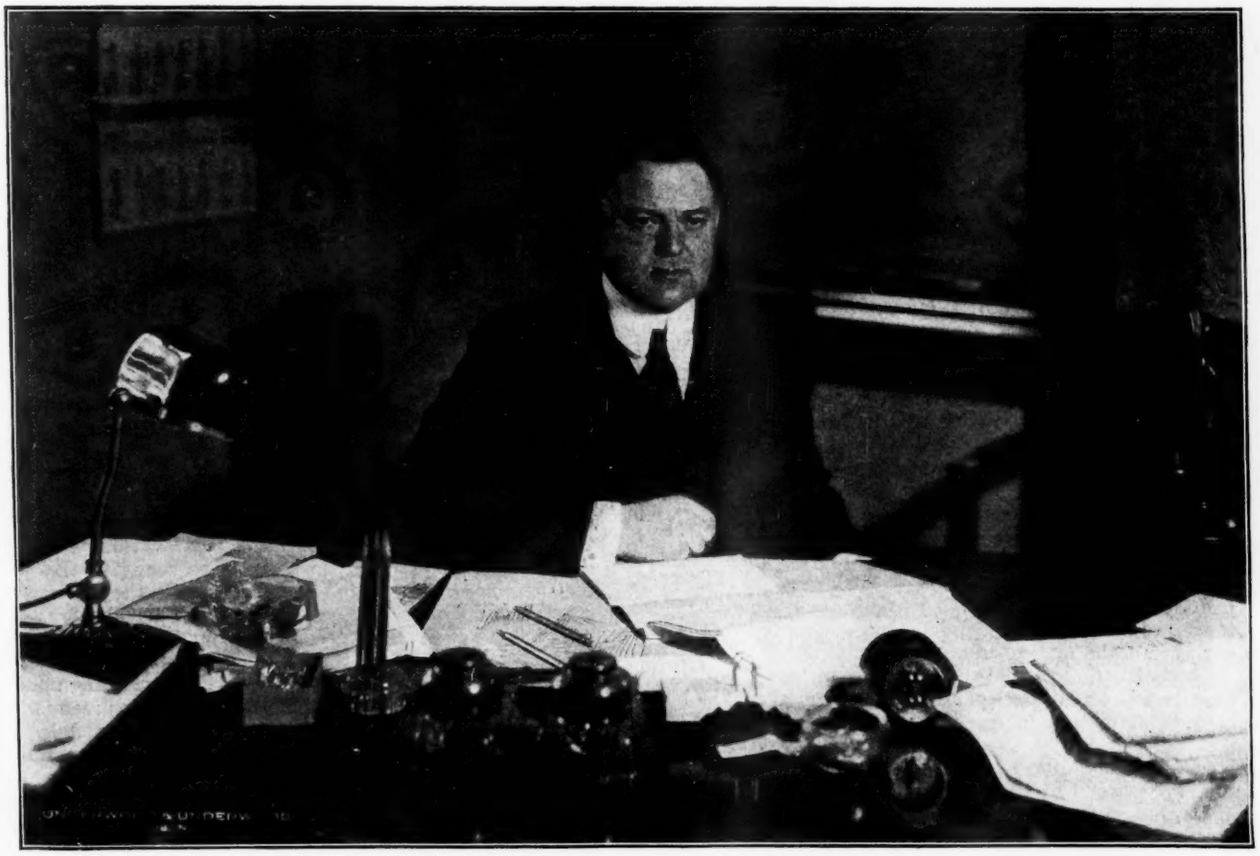
The populations of our modern states have been built up to numbers dependent upon an intensity of production that can be maintained only by stimulation of individual effort through the impulse of self-interest, and a departure from this primary incentive to production has now been demonstrated to lead only to famine and flame and anarchy.

We have built up public agencies intended to preserve an equality of opportunity through control of possible economic domination. Our mass of regulation of public utilities and of many other types of industry, aiming chiefly to prevent combinations in restraint of free enterprise, is a monument to our attempts to limit this economic domination—to give a square deal. This regulation is itself also proof of the abandonment of the unrestricted capitalism of Adam Smith. While our present system of individualism under controlled capitalism may not be perfect, the alternative offers nothing that warrants its abandonment. Our thought, therefore, needs to be directed to the improvement of this structure and not to its destruction.

A profound development of our economic system apart from control of capital and service during the last score of years has been the great growth and consolidation of voluntary local and national associations. These associations represent great economic groups of common purpose and are quite apart from the great voluntary groups created solely for public service. We have the growth of great employers' associations, great farmers' associations, great merchants' associations, great bankers' associations, great labor associations—all economic groups striving by political agitation, propaganda and other measures to advance group interest. At times they come in sharp conflict with each other and often enough charge each other with crimes against public interest. And to me one question of the successful development of our economic system rests upon whether we can turn the aspects of these great national associations toward co-ordination with each other in the solution of national economic problems, or whether they grow into groups for more violent conflict. The latter can spell breakdown to our entire national life.

This engineers' association stands somewhat apart among these economic groups in that it has no special economic interest for its members. Its only interest in the creation of a great national association is public service to give voice to the thought of the engineers in these questions. And if the engineers, with their training in quantitative thought, with their intimate experience in industrial life, can be of service in bringing about co-operation among these great economic groups of special interests they will have performed an extraordinary service.

The employer sometimes overlooks a fundamental fact in connection with organized labor in the United States. This is that the vast majority of its membership and of its direction are individualists in their attitude of mind and in their social outlook; that the expansion of socialist doctrines finds its most fertile area in the ignorance of many workers, and yet the labor organizations, as they stand today, are the greatest bulwark against socialism. On the other hand, some labor leaders overlook the fact that if we are to maintain our high standards of living, our productivity, it can only be in a society in which we maintain the utmost possibile initiative on the part of the employer; and further, that in the long run we can expand the standard of living only by the steady increase of production and the creation of more goods for division over the same numbers.



HERBERT HOOVER, PRESIDENT OF THE FEDERATED AMERICAN ENGINEERING SOCIETIES

The American Federation of Labor has publicly stated that it desires the support of the engineering skill of the United States in the development of methods for increasing production, and I believe it is the duty of our body to undertake a constructive consideration of these problems and to give assistance not only to the Federation of Labor, but also to the other great economic organizations interested in this problem, such as the Employers' Association and the Chamber of Commerce.

In the questions of industrial conflict resulting in lockouts and strikes one mitigating measure has been agreed upon in principle by all sections of the community. This is collective bargaining by which, whenever possible, the parties should settle their difficulties before they start a fight.

It is founded not only on the sense of prevention, but on the human right to consolidate the worker in a proper balanced position to uphold his rights against the consolidation of capital. This measure, advocated for years by organized labor, was agreed to by the employers' group in the First Industrial Conference. It has been supported on the platform of both political parties. The point where the universal application of collective bargaining has broken down is in the method of its execution.

Increased Production and Wasteful Unemployment

There are questions in connection with this entire problem of employer and employee relationship, both in its aspects of increased production and in its aspects of wasteful unemployment, that deserve most careful study by our engineers. There lies at the heart of all these questions the great human conception that this is a community working for the benefit of its human members, not for the benefit of its machines or to aggrandize individuals; that if we would build up character and abilities and standard of living in our people, we must have regard to their leisure for citizenship, for recreation and for family life. These considerations, together with protection against strain, must be the fundamentals of determination of hours of labor. These factors being first protected, the maximum production of the country should become the dominating purpose.

We must take account of the tendencies of our present repetitive industries to eliminate the creative instinct in its workers, to narrow their field of craftsmanship, to discard entirely the contribution to industry that could be had from their minds as well as from their hands. Indeed, if we are to secure the development of our people, we cannot permit the dulling of these sensibilities.

There is an immediate problem in increased production that is too often overlooked by the theorist. While it is easy to state that increased production will decrease cost and by providing a greater demand for goods secure increased consumption and ultimate greater employment, yet the early stages of this process do result in unemployment and great misery. It takes a variable period of time to create the increased area of consumption of cheapened commodities, and, in the meantime, when this is translated to the individual worker he sees his particular mate thrown out of employment. We accomplish these results over long periods of time, but if we would secure co-operation to accomplish them rapidly we must take account of this unemployment and we must say to them, the community, that if it is to benefit by the cheapening costs and thus the increased standard of living, or alternatively if the employer is to take the benefits, the entire burden should not be thrust upon the individual who now alone suffers from industrial changes.

Interest in Creation and Craftsmanship Must Be Kept Awake

If we are to secure increased production and an increased standard of living we must keep awake interest in creation, in craftsmanship and the contribution of the worker's intelligence to management. Battle and destruction are a poor solution to these problems. The growing strength of national organizations on both sides should not and must not be contemplated as an alignment for battle. Battle quickly loses its rules of sportsmanship and adopts the rules of barbarism. These organizations, if our society is to go forward instead of backward, should be considered as the fortunate development of influential groups through which skill and mutual consideration can be assembled for co-operation to the solution of these questions. If we could secure this co-operation throughout all our economic groups we should have provided a new economic system, based neither on the capitalism of Adam Smith nor upon the socialism of Karl Marx. We should have provided a third alternative that preserves individual initiative that stimulates it through protection from domination. We should have given a priceless gift to the Twentieth Century.

Mr. Hoover's address was followed by an informal reception and smoker tendered by the local engineering societies.

Facts About the Tonawanda Switch Station Explosion

When, on Monday morning, Nov. 1, engineers as well as laymen read in the daily newspapers the reports of the accident at the substation of the Tonawanda Power Co., at Tonawanda, N. Y., the former wondered what had happened to cause the catastrophe, and the latter accepted the report as something incident to electrical power generation and transmission. Since the occurrence of this accident it has been learned from the officials of the Niagara Falls Power Co., Niagara Falls, N. Y., that that company has a switching station at Tonawanda, adjoining the Tonawanda Power Co. substation. This switching station had no operator, since it contained no switching apparatus that was operated under load, the operator from the Tonawanda Power Co.'s substation making any changes in the disconnecting switches that might be necessary when repairs were made on the transmission lines, this being at intervals of several months.

On account of increased demands for power at Tonawanda, it became necessary to install two new current transformers in the switching station there. These transformers were insulated for 45,000 volts, while the potential of the line was only 22,000 volts. The Tonawanda Power Co. supply was shut down and a picked crew was sent by the Niagara Falls Power Co. to install the transformers and make some other connections for the enlargement of the Tonawanda company's substation. After this work had been completed and the workmen were ready to go home, the disconnecting switches were closed by the Tonawanda substation operator, this making the new installation alive. About three minutes after this a snapping sound characteristic of static discharge was heard in the switch station, and an explosion occurred involving the whole switching station.

At the time of the accident there were thirteen men in and around the station, nine of them being employed by the Niagara Falls Power Co. and the rest by the Tonawanda Power Co. Four of these men were killed instantaneously, eight died within twenty-four hours after the accident and one five days later. Apparently a number of the men sacrificed their lives in a heroic, although unsuccessful, effort to save the lives of their fellow workmen. Contrary to the belief created by the newpapers that transformers containing large volumes of oil were in the station, the only apparatus containing oil consisted of four current transformers and two potential transformers. The cases of both of the new current transformers were found broken when the fire was extinguished. Other transformers of this type have been in service for several years on the Niagara Falls Power Co. system without giving any trouble. On account of the nature of the accident it will be very difficult to determine the exact cause of the trouble.

The plans for the hydro-electric development of the Upper Adige in Italy contemplate the erection of three large generating stations. The first will be located between Glurns and Chladerns and will develop 50,000 hp.; the second will be at Castelbello and will provide 60,000 hp.; and the third, which will be the largest, will furnish 100,000 hp., making a total of 210,000 hp. Proposals to convert three lakes on the river into impounding reservoirs have been given up, since this is liable to prove disastrous to three rural communes.—*Electrical Review*, London.

Senator Edge's Version of Coal Profiteering

Intervention by the Government, rather than the nationalization of the coal industry, is the desire of Senator Edge of New Jersey. The announcement made by the Senate Committee on Reconstruction and Production has led to a general assumption that Senator Edge is willing to see the coal mines nationalized, if the industry itself does not clean house before Dec. 6. To correct any misunderstanding of this point, a formal statement was made public at the Senator's office Nov. 20. Excerpts from the statement follow:

In the recent and prevailing high prices and shortage of coal, both bituminous and anthracite, a condition has arisen in that industry which, unless soon corrected, will in my judgment compel the people to intervene. Who is to blame for these high prices—these apparently unreasonable and unjustified prices—must be determined, and those to blame must be brought to reason, even if it be necessary for the people, through their own agency in "Government," to take steps toward that end. Apparently, the various elements engaged in the coal industry are unable to place this blame where it belongs. So much time, energy and ingenuity are expended in the merry sport of "passing the buck" that the man on the sidelines is inclined to wonder how the industry finds time to provide coal.

"I'm not to blame," says the miner, "it's the operator." Then, "Not guilty," says the operator, "it's the middleman"; and he in turn blames the railroads for car shortage, and the gladsome game of "Here we go round the mulberry bush" continues with enthusiastic cheer. But, with each of these groups accusing the other, the people are moved to wonder whether, after all, each one of them is not somewhat to blame and whether all may not be involved in the boosting of prices.

At all events, the people have been suffering and are suffering from high prices and short supplies. The average American citizen is the most patient mortal of all the peoples of the earth, but even his patience has a limit. The cold fact is that the people now look on the coal industry as a private oppressor of the public, and when the American people are driven to this extremity of view, their alleged oppressor may do well to pause and ponder. As I said, when the people suffer, the business which causes that suffering is bound to suffer also.

When, recently, I spoke of possible "Government intervention" to remedy the apparent evils in the coal industry, the ogre of bureaucratic intervention arose to plague some folks at interest. So dim is the recollection in these days that the people are "the Government" that such folks saw visions only of some autocratic agency despotically taking possession of their business and "meddling in their affairs." The truth would be that the people themselves had rebelled against oppression and had instructed their chosen representatives in the Legislative and Executive departments to act for them in relieving such oppression.

The situation is desperate. In my own state, New Jersey, coal is unobtainable in many sections and, where obtainable, may be purchased only at sky-high prices. Identical reports come from virtually every state in the Union. Who is to blame for this situation? If the component groups of the coal industry cannot ascertain, then the people, through their chosen representatives, must do so. If the coal industry will not, or cannot, immediately remedy conditions, the people through their chosen representatives must and will do so.

Sound business men and the average citizen will hope that such intervention may be only temporary and even of short duration, and that the Government, which is the people, soon may be relieved of the task of directing an industry of private nature. But in their extremity of suffering, their experience of Government management of the railroads is nearly forgotten and the possibility of Government control of coal does not appall them. For the people have been accustomed to seeing the Government, under the present Administration, intrude into numerous lines of private business. They have seen the Government engaged in the real-estate business, in hotels and boarding houses and theaters, in the wholesale and retail grocery trade, in women's hosiery handled by the War Department—in everything, from cough drops to coffins and from antiques to ziziths. They still disapprove Government ownership or control, but they may be driven to a state of willingness to try the experiment.

The people do not ask much: Only reasonable prices and adequate supplies for the consumer, legitimate profits for the operators and distributors, fair wages and treatment for the miners and reasonable dividends for the owners of the railroads over which coal is transported.

"The Engineering of Men" To Be Discussed

The Taylor Society, which has for its object the promotion of the science and the art of administration and management, has arranged a meeting for Friday evening, Dec. 3, at which the subject will be "The Long Day in the Steel Industry—A Problem in the Engineering of Men." This meeting will be a joint session with the Metropolitan and Management sections of the American Society of Mechanical Engineers and the New York section of the American Institute of Electrical Engineers, and will be held at 8 o'clock in the Engineering Societies Building, New York City. Fred J. Miller, president of the A. S. M. E., will preside.

A report on "The Three-Shift System in the Steel Industry" will be presented by Horace B. Drury, who was recently associated with the United States Shipping Board and who has been for the last few months visiting practically all the steel plants in the United States that are working under the three-shift system, collecting technical data on the details of their operation and figures showing the results obtained.

William B. Dickson, vice president of the Midvale Steel and Ordnance Co., will give the point of view of the manufacturer, after which there will be a general discussion, led by Robert B. Wolf, consulting engineer, of New York City.

The Taylor Society's business session will be held on Dec. 2, but throughout the day on Friday and Saturday, Dec. 3 and 4, public sessions will be held to which those interested are invited. The subject of Friday's session will be "Scientific Management in the Sales Department," and on Saturday "Standardization of Products" will be discussed. A final meeting will be held Saturday evening at 8 p.m., at which there will be a general discussion of "Risk —A Retarding Factor in Production."

Research Information Bureau Established

The National Research Council has established the Research Information Service as a general clearing house and informational bureau for scientific and industrial research. This "Service" on request supplies information concerning research problems, progress, laboratories, equipment, methods, publications, personnel, funds, etc.

Ordinarily, inquiries are answered without charge. When this is impossible because of unusual difficulty in securing information, the inquirer is notified and supplied with an estimate of cost.

Much of the information assembled by this bureau is published promptly in the "Bulletin" or the "Reprint and Circular Series" of the National Research Council, but the purpose is to maintain complete up-to-date files in the general office of the Council. Announcement will be made from time to time of special informational files which have been prepared.

Requests for information should be addressed: Research Information Service, 1701 Massachusetts Avenue, Washington, D. C.

Mining Engineers Working on the Coal Problem

The American Institute of Mining and Metallurgical Engineers' Committee on the Stabilization of the Bituminous Coal-Mining Industry has prepared a set of conclusions, which are as follows:

1. That the bituminous industry, by the nature of its organization, functions economically in a too inefficient manner. Employment in the industry averages less than 220 days per annum, with a minimum district average of less than 200 days. Thus a labor staff and capital investment of fully 30 per cent more is required than otherwise would be necessary. From this flow a high daily wage, a considerable portion of the just complaints of labor and a higher cost of coal to the consumer.

2. The causes are very largely (a) intermittency in seasonal demand, (b) irregularity of car supply and (c) the lack of storage facilities and incentive for their use.

3. The cure lies in: (a) The co-operation of railroads in the establishment of seasonal differentials in rates that will induce summer demand; (b) increased transportation facilities and a more efficient and equitable distribution of cars; (c) increased use of central and interconnected electric-power plants; (d) lower selling prices in dull seasons made possible by differentials in profits, freight rates and wages; (e) recognition by the larger consumers, such as the Federal, state and municipal institutions, railroads, public utilities and industrial plants, that not only continuity of operation, but also the safety of the public from the stoppage of supply, demands that they provide adequate storage to be replenished in the dull season.

4. Such storage is feasible and can be made financially remunerative by differential rates and prices. Public safety demands the installation of storage facilities at the place of consumption.

5. No adequate solution can be found, except through organized co-operation of operators, labor, railroads and large consumers. Under existing laws as to combinations, such co-operation cannot be carried on. Therefore, we believe that some Federal legislation is necessary, permitting such co-operation under competent Government authority.

Engineering Examiners Form National Council

Representatives of seven state boards of engineering examiners met in Chicago on Nov. 8 and 9 in response to a call sent out by K. C. Kastberg, city engineer, Des Moines, and formed the National Council of State Boards of Engineering Examiners. The purpose of the new organization is "to examine the state laws providing for registration of engineers and the customs and rule of procedure of the different boards in the examination of applicants, with suggestions and recommendations for uniformity of practice so far as it can be done legally by the different state boards, and to provide for reciprocal relations between the state boards for granting registration licenses to applicants from other states on equal terms of examination."

It was realized that there was little chance of ever getting a uniform law in all the states, so that the practical thing to do would be to provide as nearly as possible for uniformity in administration. Seven states are now represented in the Council, and it is to be hoped that the four other states that have license or registration laws will join. The states represented are Iowa, Illinois, Florida, Louisiana, South Dakota, Michigan and Colorado.

Throughout the meeting there was prolonged discussion of the provisions in the proposed draft of the uniform law recently approved by Engineering Council. The following resolutions, which were finally passed, indicate the unanimity of opinion on reciprocity: (1) That where a qualified engineer obtains a contract he be permitted to proceed after filing an application and pledging himself to appear for examination at the next board meeting; (2) that efforts be made by the several states to standardize the examination; (3) that the members of the various boards be granted reciprocity license or registration without examination.

The officers elected were as follows: President, Marcel Garsaud, New Orleans; vice president, C. S. Hammatt, Jacksonville, Fla.; secretary-treasurer, Alvin LeVan, Des Moines, Iowa. The next meeting will be held on Oct. 3, 1921, in St. Louis.

Admiral W. S. Benson, Chairman of the United States Shipping Board, discussed the "Demands of the Shipping Board for Oil" before the American Petroleum Institute recently. He impressed it upon his hearers that "we are now facing the most unrelenting and stifling competition of nations trained in all the fine points of ship operation. One of our greatest advantages lies in the fact that about 75 per cent of our entire fleet burns oil for fuel, as compared with about 15 per cent for all foreign shipping. This advantage cannot be realized to the fullest extent unless the Shipping Board and the American Merchant Marine as a whole can be assured of an adequate supply of fuel oil not only now but, of more importance, in the future as well, at reasonable prices."

The Bureau of Mines is conducting tests at the Northwest Experiment Station, Seattle, Washington, for the purpose of developing efficient methods of washing coal. This is made necessary by the very poor quality of coal which is frequently mined nowadays. The process under consideration depends upon differences in specific gravities between the clean coal and its associated impurities. The co-operation of several coal-mining companies has been secured and gratifying results obtained.

From 8,000 to 10,000 tons of American coal per month is sent to Constantinople at prices ranging from $35 to $42 per ton.

New Publications

LESSONS IN MECHANICS. By Franklin and McNutt. Published by Franklin & Charles, Bethlehem, Pa. 218 pages; 175 illustrations. Price, $2.

This volume was prepared for use as a textbook in technical high schools and covers the field of elementary mechanics in a very praiseworthy manner. The method of treatment should be highly satisfactory for schoolroom work since the examples given deal with familiar objects. It is rather difficult to treat of mechanics without the use of calculus, and since the student is not supposed to have covered calculus a very successful attempt is made to explain the higher mathematics evolved in motion and elasticity.

EFFICIENT OIL BURNING. By Arthur H. Light. Published by the Coen Company, San Francisco, Cal. Cloth; 70 pages; Price, $2.50.

The author of this unique little volume on furnace combustion, with many years of experience in the use of fuel oil, conceived the idea of implanting knowledge of the elementary principles of combustion in the minds of engineers through the agency of a simple text embellished with innumerable figures or moving pictures. The author terms it "Graphic Description." On first opening the volume the reader may be struck by the apparent childishness of the figures termed oxyes, nitroes, carbies, etc., but on reading a few pages, will be constrained to acknowledge that the method of treatment does impress the mind with the basic principles of combustion more effectually than would a more abtruse work. The engineer will find the volume well worth the price asked for it.

MODERN WELDING METHODS. By Victor W. Page, M. S. A. E. Published by Norman W. Henley Publishing Co., New York, 1920. Cloth; 5½ x 8 in.; 292 pages; 113 illustration; 16 tables. Price, $3.

Autogenous welding for joining metals has made rapid progress during the last few years, so much so that it has become almost an indispensable art in many industries. In the welding process it is now recognized that the welder is a very important factor in the making of a good weld, therefore this book, which treats of the practice in the use and practical application of oxyacetylene welding and cutting torches, spot, arc and butt systems of electric welding, thermit process, brazing and soldering processes, and forge welding and heat treatment of steel, has a wide field of usefulness. The subjects are treated in a simple non-technical manner for the use of students and practical mechanics rather than the engineer—for those who are more interested in the practical applications than in the theory of welding.

THE A B C OF STORAGE BATTERY MANAGEMENT. By Ernest C. McKinnon, A. M. I. E. E. Published by Electrical Press, Ltd., London, England. Size 5 x 8 in.; 95 pages; 31 illustrations. Price, 3s. 10d.

In this little book an attempt has been made to present in plain language the essential features in the installation, care and maintenance of storage batteries, also the rudimentary points that anyone undertaking the operation and management of storage batteries should be familiar with. The text is divided into eight chapters: What to guard against in storage battery operation; battery-room requirements; how to take hydrometer readings; daily inspections; general upkeep; battery terms and definitions. Although the book represents British storage-battery practice, most of the material is equally applicable to lead batteries of every make. The collection of 200 battery terms in the last chapter should prove of particular value to those who are non-technical and wish to become familiar with the storage-battery subject.

DIRECT-CURRENT MOTOR AND GENERATOR TROUBLES. By T. S. Gandy and E. E. Schacht. Published by McGraw-Hill Book Co., Inc., New York City, 1920. Cloth; 5 x 8 in.; 274 pages; 109 illustrations. Price, $2.50.

In general, the designing, construction and installation of power equipment covers a comparatively short period when measured by the operating life of the machine. It is the operating man's job to keep the equipment going throughout the life of the machine after it has been installed, and this book has been written for the purpose of giving the methods which many years of experience have proved to be both simple and effective for testing and remedying direct-current motor and generator trouble. In addition the selection, operation, care and repair of direct-current machinery are analyzed from the standpoint of the operator. The book is divided into nine chapters: Types of motors and their uses; types of generators and their uses; erection and assembly of direct-current motors and generators; starting and operation of direct-current motors and generators; direct-current switchboards; troubles and their remedies; tests and repairs and useful data. Features of plant operation that are always closely associated with the operator's interests are motor and generator troubles, their remedy and repair. In this book 150 pages have been devoted to these subjects, and the authors' long experience with direct-current machinery has familiarized them with this class of equipment in all its conditions.

Personals

DeWitt M. Taylor has been appointed instructor in mechanical engineering, Massachusetts Institute of Technology, Cambridge. He was formerly Associate editor of *Power*.

John A. Stevens, consulting engineer, of Lowell, Mass., is leaving for a month's relaxation in Europe. Can you see John relaxing?

William Miltz, formerly manager of the Certigraph Co., Cincinnati, is now general superintendent of construction for the Lamson Co., Boston, Mass.

F. R. Stevens, chief engineer of the American Locomotive Co., has been transferred from the Richmond (Va.) to the Schenectady office of this company.

D. W. Frazer, formerly general manager of the Montreal Locomotive Works, Ltd., is now located in New York City. Mr. Fraser is vice president of the American Locomotive Company.

L. A. Baldwin is now associated with the H. W. Johns-Manville Co., St. Louis, Mo. He was formerly superintendent of the boiler department of the Empire Gas and Fuel Co., Eldorado, Kan.

Charles G. Keshen is now associated with The Gifford-Wood Co., of Hudson, N. Y., as an engineer on coal-handling and conveying apparatus. He was formerly with the Lamson Co., of Boston, Mass.

L. L. Jordan has left the Foxboro Co., of Foxboro, Mass., and is now sales engineer with the Chadburn Engineering Co., of Troy, N. Y., which has recently placed a new type of CO_2 indicator on the market.

Leon H. Johnson has severed his connection as general manager with the Anderson Foundry and Machine Co. and will in the future be at the head of an engineering firm specializing on oil-engine power plants as well as manufacturing oil engines, at Anderson, Ind.

Society Affairs

The American Society of Refrigerating Engineers is to hold its annual meeting on Dec. 6, 7 and 8 at the Hotel Astor, New York City.

The Detroit Section of the A. S. M. E. is to hold a joint meeting with the Michigan Heating and Ventilating Society on Dec. 3. "Modern Efficiency of Heating and Ventilation" will be discussed by Dr. Hill.

The Detroit Engineering Society will meet on Dec. 3 to hear an address by Dexter S. Kimball, professor of engineering at Cornell University, on "A Broader Field for the Engineer."

The Engineer's Club of Philadelphia will hold a meeting on Dec. 3, at which "The Use of Powdered Anthracite and the Recovery and Use of River Coal" will be discussed by members and engineer guests.

The Taylor Society will hold its annual meeting on Dec. 2, 3 and 4. On the evening of Dec. 3 a joint meeting with the A. S. M. E. and the A. I. E. E. will be held, at which the subject will be "The Long Day in the Steel Industry." The program appears elsewhere in *Power*.

The Philadelphia Section of the Association of Iron and Steel Electrical Engineers will hear an address on Dec. 4 by H. C. Boynton and W. A. Voigtlander, on "Instruction in the Care, Use and Inspection of Flexible Steel Cables." Technical sessions of the association are held at 8 p.m., preceded by informal dinners at 6 p.m.

Business Items

The Chicago Pneumatic Tool Co. announces the removal of its rock-drill plant from 864 East 72nd St., Cleveland, Ohio, to its Boyer Pneumatic Hammer plant at 1301 Second Blvd., Detroit. The location of the company's Little Giant Air Drill plant at 1241 East 49th St., Cleveland, remains unchanged.

COAL PRICES

Eastern Seaboard—Wholesale prices on bituminous are about as follows:

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$4.50@$5.50	$5.00@$6.50
F.o.b. Philadelphia, gross tons	7.70@ 8.80	8.25@ 9.90
F.o.b. New York, gross tons	8.15@ 9.25	8.70@10.35

New York—Quotations at mines: Pool 14, $4.50@$4.75; Pools 71 and 9, $5.75@$6.25; Pool 10, $4.75@$5.50; Pool 11, $4.50@$4.75.

Midwest—Mine prices of principal coals used in central Ohio:

Hocking lump	$4.50@$5.75
Hocking mine run	4.00@ 5.00
Hocking screenings	3.50@ 4.25
Pomeroy lump	4.50@ 6.00
Pomeroy mine run	4.00@ 5.25
Pomeroy screenings	3.75@ 4.00
West Virginia splints, lump	5.00@ 6.50
West Virginia splints, mine run	4.75@ 5.50
West Virginia splints, screenings	4.25@ 5.25
Pocahontas lump	6.50@ 7.00
Kentucky lump	5.25@ 6.50
At mines in Southern Illinois:	
Prepared sizes	$5.25@$6.50
Mine run	4.75@ 5.50
Screenings	3.75@ 4.25
At mines in Springfield District:	
Prepared coal	4.75@ 6.25
Mine run	3.25@ 4.00
Screenings	2.75@ 3.25
At Mines in Northern Illinois:	
Mine run	3.75@ 4.50
Screenings	4.00@ 4.50

South—Birmingham, Ala., reports the following quotations: Cahaba and Black Creek mine run, $5.50@$6; Carbon Hill grades, $4@$4.50.

New Construction

PROPOSED WORK

Mass., Cohasset—The city had sketches prepared for a 2 story municipal building. About $500,000. G. F. Newton, 6 Beacon St., Boston, Archt.

Mass., New Bedford—The Bd. Educ. will soon award the contract for a 2 story, 171 x 184 ft. grammar school including a steam heating system on Summer St. About $600,000. Smith & Howland, Bartlett Bldg., Archts.

Mass., South Hadley—The Mt. Holyoke College, M. E. Wooley, Pres., is having plans prepared for a 3 story dormitory including a steam heating system. About $500,000. Brainerd & Leeds, 89 Franklin St., Boston, Archt.

Conn., Fairfield—The DuPont Fabrikoid Co. plans to increase its sub-station capacity to 100 kva. and the motor load by 250 hp. L. A. Beecher, Supt.

N. Y., Brooklyn—The Y. M. H. A., c/o Mr. Moscowits, 189 Montague St., plans to build a 13 story Y. M. H A. building including a steam heating system at 4th Ave. and Dean St. Archt and Engr. not selected.

N. Y., Middletown—The State Hospital Comn., Capitol, Albany, will soon receive bids for a 3 story, 44 x 320 ft., 3 wings, 37 x 76 ft. chronic hospital at the Middletown State Hospital here. About $400,000.

N. Y., Oswego—The city plans to build a 3 story, 200 x 264 ft. high school, including a steam heating system on Utica St. J. A. Randall, S. A. & K. Bldg., Syracuse, Archt. and Engr.

N. J., Atlantic City—The Bd. Educ., c/o Mr. Power, Atlantic and Pacific Aves., plans to build a 3 story high school including a steam heating system. About $1,000,000. Archt. not selected.

N. J., Burlington—The Masonic Order of Burlington, 15 West Union St., will soon award the contract for a temple including a steam heating system. About $300,000. W. T. Arnold, Meriden, Conn., Archt. and Engr.

N. J., Trenton—R. C. Maxwell Co., 413 East State St., will soon receive bids for an 8 story, 97 x 193 ft. office building. Walter Hankin, 241 South Warren St., Archt.

Pa., Altoona—The City Commissioners, c/o H. G. Hinkle, City Mgr., plans to build a 30 x 60 ft. reservoir and install two electrically-driven, automatically-controlled pumps. F. D. Hain, City Hall, Engr.

Pa., Butler—The Butler Memorial Hospital, c/o Dr. T. M. Maxwell, Pres., plans to build a 3 story hospital extension including a steam heating system on Brady Street. About $500,000. E. L. Tilton, 52 Vanderbilt Ave., New York City, Archt. and Engr.

Pa., New Wilmington—The Water Supply Co. is in the market for a 25-hp. gas engine, a force pump and air compressor.

Pa., Philadelphia—The Colonia Garage, 28 East Mount Airy Avenue, is in the market for an 8 x 36 ft. upright boiler.

Pa., Sharpsburgh (Pittsburgh P. O.)—The Borough received bids for pumping station from Pitt Constr. Co., Fulton Bldg., Pittsburgh, $41,900; D. T. Riffle, Keenan Bldg., Pittsburgh, $45,763; Fort Pitt Constr. Co., Martin Bldg., Pittsburgh, $46,369.

Va., Winchester—Estate of Judge Hanley, c/o F. E. Clark, is having plans prepared for a 3 story Handley Memorial School. About $1,000,000. S. H. Edwards, and W. R. McCormack, East 6th St., Cleveland, Associate Archts.

W. Va., South Charleston—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., received bids for direct-current distribution centers in machine shop at the U. S. Naval Ordnance Plant here, from the General Electric Co., River Rd., Schenectady, N. Y., $14,565 and the Westinghouse Electric & Mfg. Co., 803 Hibbs Bldg., Washington, D. C., $18,382.

N. C., Kinston—The city plans to enlarge the electric light and power plant and install machinery and boilers. About $300,000.

N. C., Lenoir—The Granite Falls Mfg. Co., Granite Falls, has applied for permission to build dam, power house, reservoir, etc., on Wilson Creek for public service here. A. A. Shuford, Secy.

N. C., Scotland Neck—The city plans to install a new lighting system. About $50,000.

N. C., Spruce Pine—Col. D. W. Adams, Old Fort, is promoting a hydro-electric project on the Toe River near here. About several hundred thousand dollars.

Fla., Apalachicola—The city voted $50,000 bonds for an electric light plant.

Ala., Montgomery—The Alabama Power Co., Birmingham, has been granted a writ of convenience from the State Public Service Comn. for the construction of a dam and hydro-electric power plant on the Coosa River near Lock 12.

Ky., Louisville—The Ford Motor Co., 2500 South 3rd St., plans to build a 100 x 200 ft. addition to the present automobile assembling plant. About $500,000.

O., Cleveland—The Hayden Investment Co., c/o H. Kangesser, Park Bldg., has purchased site on East 30th St. and Prospect Ave. and plans to build a 5 story, 80 x 210 ft. garage and commercial building including a steam heating system. About $400,000. J. L. Weinberg, Schofield Bldg., Archt.

O., Cleveland—S. S. Koslen, 1077 East 97th St., plans to build a 7 story, 69 x 190 ft. hotel including a steam heating system on Euclid Ave. About $500,000. Archt's. name withheld.

O., Dayton—The Association of Jewish Congregations plans to build a 4 story hospital on Forest Ave. About $400,000. S. Meyerburg, North Jefferson St., Chn. Archt. not selected.

O., Dayton—The Bd. Educ., C. H. Britton, Secy., plans to build a 3 story high school on Summit St. About $750,000. Schenk & Williams, Mutual Home Bldg., Archts.

O., Massillon—The First Nat'l Bank, P. L. Hunt, Pres., plans to build a 6 story, 40 x 144 ft. bank and office building including a steam heating system on Main St. About $300,000. Wm. R. Powell, Rose Bldg., Cleveland, Archt.

O., Milo (Columbus P. O.)—The Bd. Educ., Columbus, is having preliminary plans prepared for a 2 story, 110 x 200 ft. school here. About $265,000. Riebel & Sons, New First Nat'l Bank Bldg., Columbus, Archts.

O., Springfield—The Wittenburg College, c/o Dr. C Huckert, Pres., College Hill, plans to build a 3 story gymnasium and auditorium. About $500,000. Archt. not selected.

O., Youngstown—The Central Bank & Trust Co., Central Sq., plans to build a 12 story, 40 x 180 ft. bank and office building. About $1,500,000.

Ind., Evansville—The Evansville College, 6 North Michigan Ave., will receive bids in December for a 3 story, 66 x 174 ft. college building on Lincoln Ave. About $400,000. Fullenwider & Dowling, Chicago, Ill., Archts.

Ind., Gary—The First Methodist Episcopal Church is having plans prepared for a 125 x 235 ft. church and community building including a steam heating system at West 6th St. and Washington Ave. About $650,000. Lowe & Bollenbocker, 108 South La Salle St., Chicago, Ill., Archts.

Mich., Birmingham—The Bd. Educ. will soon award the contract for a 2 story, 128 x 165 ft. school including a steam heating system at Adams St. and Oakland Ave. Baxter, O'Dell & Halpin, 1024 Hammond Bldg., Archts.

Mich., Detroit—The Northwestern Bldg. Corp., 2063 West Grand Boulevard, is having plans prepared for a 2 story theater and office building including a steam heating system. About $2,000,000. C. W. & G. L. Rapp, 190 North State St., Chicago, Ill., Archts.

Mich., Detroit—St. Thomas' Church, Thomas Ave., is having plans prepared for a 2 story, 64 x 98 ft. school and a 34 x 48 ft. steam heating plant annex. About $175,000. Van Leyen, Schilling, Keough & Reynolds, 566 Cass Ave., Archts.

Mich., Lansing—The Lansing Agriculture College had preliminary plans prepared for a club house including a steam heating system. About $500,000. Pond & Pond, 64 East Van Buren St., Chicago, Ill., Archts.

Mich., Saginaw—The Bd. Educ. is having plans prepared for a 3 story, 173 x 282 ft. school including a steam heating system on Weadock and Park Sts. About $1,000,000. Cowles & Mutscheller, Chase Block, Archts.

Ill., Chicago—The Lake Shore Trust & Saving Bank, Michigan Ave. and Ohio St., is having plans prepared for a 6 story bank and office building including a steam heating system. Marshall & Fox, 721 North Michigan St., Archts.

Ill., Chicago—The Chicago Women's Club, 410 South Michigan Ave., is having preliminary plans prepared for a 9 story, 104 x 120 ft. club house including a steam heating system on 11th St. About $1,100,000. Pond & Pond, 64 East Van Buren St., Archts.

Ill., Chicago—The Evangelical Lutheran Immanuel Church, c/o E. E. Hall, Archt., 123 West Madison St., is having plans prepared for a 1 and 2 story, 123 x 210 ft. church and social center building including a steam heating system at Ellendale & Greenview Aves. About $400,000.

Ill., Chicago—Cook County, c/o Eric E. Hall, Archt., 123 West Madison St., is having preliminary plans prepared for a 3 story juvenile home including a steam heating system at Roosevelt Rd. and Ogden Ave. About $600,000.

Ill., Chicago—The Sheridan Trust & Savings Bank, Bway. and Lawrence Ave., is having plans prepared for a 10 story bank and office building including a steam heating system. Marshall & Fox, 721 North Michigan Ave., Archt.

Ill., Chicago—B. H. Rosen, 4854 North Irving Ave., plans to build a 5 story, 100 x 130 ft. hotel including a steam heating system at Rogers Park. About $350,000. Ralph C. Harris, 190 North State St., Archt.

Ill. Chicago—The Pilgrim Congregational Church, 64th St. and Harvard Ave., plans to build a 2 story, 100 x 122 ft. church and community house including a steam heating system. About $500,000. C. B. Falkner, 140 South Dearborn St., Archt.

Ill., Chicago—The First Methodist Episcopal Church, 77 West Washington St., is having preliminary plans prepared for a 20 story, 80 x 180 ft. church and office building including a high pressure steam heating system at Washington and Clark Sts. Holabird & Roche, 104 South Michigan Ave., Archts.

Ill., Waukeegan—The Victory Memorial Hospital, c/o Schmidt, Gardner & Mortin, Archts., 104 South Michigan St., will soon award the contract for a 2 story, 40 x 340 ft. hospital and a 1 story, 25 x 90 ft. power house. About $300,000.

Wis., Jefferson—The Jefferson Rubber Co., c/o C. Girton, is in the market for several electric motors, to be used in connection with a new rubber tire factory.

Wis., La Crosse—The Wisconsin-Minnesota Light & Power Co., 120 North 5th St., plans to build a new 10,000-kw. steam power plant and extend its electric lines to Hokah, Minn., and Sparta, Wis. About $50,000. F. G. Felton, Mgr.

Wis., Milwaukee—The Milwaukee Bridge Co., 1400 34th St., will have plans prepared for the installation of additional boilers. Cahill & Douglas, 217 West Water St., Engrs.

Iowa, Cedar Rapids—The Bd. Educ., K. Mategil, Secy., will soon receive bids for four high schools including steam heating systems. About $1,200,000. Rugh & Zalesky, 811 Securities Bldgs., Des Moines, Archt., F. Tustison, 355 Auditorium Bldg., Minneapolis, Minn., Engr.

Minn., Annandale—The Bd. Educ. is having plans prepared for a 2 story, 110 x 154 ft. high school including a steam heating system. About $250,000. C. H. Parsons, 600 Builders' Exchange, Minneapolis, Archt.

Minn., Eveleth—The Bd. Educ., J. M. Stearns, Clk., will receive bids in January for a 3 story, 140 x 200 ft. vocational high school including a steam heating system. About $750,000. W. T. Bray, 817 Torrey Bldg., Duluth, Archt.

Minn., Minneapolis—Dr. A. H. Parks, Chn. of a group of 100 physicians and dentists, 706 Physicians & Surgeons Bldg., plans to build a 12 story office building. About $1,000,000. Archt. not selected.

Minn., Minneapolis—The Bd. Educ., G. F. Womrath, Supt., 305 City Hall, plans to remodel a grade school into a junior high school including a steam heating system at 410 James Ave., North. About $250,000.

Kan., Belleville—The Chicago, Rock Island & Pacific R.R., 139 West Van Buren St., Chicago, Ill., is having plans prepared for a 1 story, 32 x 80 ft. ice manufacturing plant, here. About $80,000. A. T. Hawk, c/o above address, Archt.

Kan., Pleasanton—The city will soon award the contract for a new power plant and two 250-hp. boilers, direct-connected 200-kva. generator, switchboard, condenser, etc. A. T. Archer Co., 609 New England Bldg., Kansas City, Mo., Engrs.

Neb., Norfolk—The Bd. Educ., B. Wolford, Secy., had plans prepared for a 2 story high school including a steam heating system. About $450,000. J. C. Stitt, Archt.

Neb., Wymore—The Wymore Hotel Co., c/o J. S. Jones, is raising funds for a 100-room hotel including a steam heating system. About $350,000.

S. D., Watertown—The South Dakota Packing & Shipping Co. plans to build a 4 story packing house. About $300,000. F. R. Hewitt, Pres.

Mont., Ronan—Mayor J. P. Swee, Missoula County, has made application for permission to build a dam, power house, etc., at Crow Creek, here.

Mo., St. Louis—The Smith & Davis Mfg. Co., 1925 Locust St., plans to build a furniture factory on Goodfellow Ave. About $1,000,000. Archt. not selected.

Mo., St. Louis—The Knights of Columbus, c/o L. E. Hart, LaSalle Bldg., plans to build a clubhouse on Lindell Blvd. About $1,000,000.

Mo., St. Louis—The Power Truck & Tractor Co., Beard and Goldsmith Sts., Detroit, Mich., plans to build an auto truck factory at Mead St. and the Wabash RR., here. About $250,000. Architect not selected. B. B. Craven, Chemical Bldg., St. Louis, Mo., Agt.

Mo., St. Louis—The Southern Car Wheel Co., Ry. Exchange Bldg., plans to build a car wheel factory at Marcus Ave. and Terminal R.R. About $500,000. Archt. not selected.

Tex., Dallas—The Methodist Episcopal Church, c/o Bishop W. N. Ainsworth, Austin, plans to build a hospital here. About $1,000,000. Engr. not selected.

Tex., Port Arthur—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until Dec. 15, for a 14 x 39 ft. radio station here. Noted Nov. 23.

Wash., Seattle—The University of Washington Y. M. C. A. plans to build a 4 story, 65 x 85 ft. club at North 42nd and East 15th Sts. Baker, Vogel & Evans, Men's Building on university campus, Archts.

Wash., Seattle—J. D. Ross, Supt. of Lighting, has asked the Board of Pub. Wks. for permission to equip 4 of the 14 boilers at the Lake Union steam plant with automatic stokers at a cost of $147,000.

Cal., Exchequer—The Merced Irrigation District, Merced, has applied for permission to build a dam here for power purposes and to operate drainage pumps.

Cal., Los Angeles—J. Harvey Pierce, 4838 Elmwood Ave., has made application for permission to build 3 dams and 3 power houses for mining and lighting purposes.

Cal., San Francisco—J. G. Van Zandt, c/o W. L. Huber, First National Bank Bldg., has applied for preliminary permit to build a power house, reservoir, etc., at Bear and Santa Anna Creeks, here.

Ont., London—The Utilities Comnrs. will have plans prepared for a 2 story, 45 x 70 ft. sub-station on Cabell St. and are in the market for transformers, generators, switches, etc. About $85,000. E. V. Buchanan, Hydro Offices, Engr.

CONTRACTS AWARDED

Mass., Charlestown—The Charlestown Gas & Electric Co., 27 Main St., has awarded the contract for a 1 story, 40 x 50 ft. substation on Salem St. to W. M. Bailey, 88 Broad St., Boston. Noted Nov. 23.

R. I., Woonsocket—The Enterprise Dye Wks., Inc., 229 1st Ave., has awarded the contract for a 1 story, 25 x 40 ft. boiler plant to the Eastern Constr. Co., 660 Winter St., at $15,000.

Conn., New Haven—The Sheldon Co., Congress Ave., has awarded the contract for a power house to J. N. Leonard & Co., 952 Chapel St., at $15,000.

N. Y., New York—The Baker & Williams Co., 126 Le Roy St., has awarded the contract for a 9 story, 75 x 100 ft. warehouse addition including a steam heating system at 110 Le Roy St. to Cauldwell-Wingate, 381-4 4th Ave.

Md., Baltimore—The Protestant Episcopal Cathedral of Incarnation, University Parkway, has awarded the contract for a 2 story, 50 x 140 x 70 ft. Synod Hall to Morrow Bros., 1201 Fidelity Bldg., at $270,000. A steam heating plant will be installed in same

D. C., Washington—The Engineer's Office, War Dept., has awarded the contract for furnishing 4 sets of controller devices for 5-hp. motors to Cutler-Hammer Mfg. Co., 50 Church St., New York City, at $978.12.

W. Va., Beech Bottom (Wellsburg P. O.)—The West Penn Power Co., Hartje Block, Pittsburgh, Pa., has awarded the contract for a 1 story power storage building, here, to the Austin Co., Pittsburgh, Pa., at $40,000.

La., New Orleans—The Linde Air Products Company, 30 East 42nd St., New York City, will build a 1 story, 125 x 125 ft. oxygen factory including a steam heating system, here. About $300,000. Work will be done by day labor.

O., Dayton—The Miami Ice Delivery Co., Ludlow Bldg., has awarded the contract for a 1 story, 60 x 60 ft. ice plant to Blanchard Bldg. Co., at $50,000.

Wis., Milwaukee—The Standard Oil Co., Brumder Bldg., has awarded the contract for the foundation of a 4 story, 75 x 100 ft. office and service building on Sycamore St. to the Universal Constr. Co., 79 Wisconsin St., at $300,000.

Wis., Milwaukee—The Hercules Knitting Co., 1097 Greenbush St., has awarded the contract for a 1 story, 30 x 80, 30 x 40 ft. factory addition to Kroening Constr. Co., Majestic Bldg., at $45,000. Electric motors will be installed in same.

Wash., Seattle—The Pacific Telephone & Telegraph Co., 333 Grant St., San Francisco, Cal., has awarded the contract for a 10 story, 111 x 120 ft. exchange building here, to the Sound Constr. & Engr. Co., Lowman Bldg., Seattle, at $1,000,000. A steam heating system will be installed in same.

Cal., Mare Island—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., has awarded the contract for the installation of a heating system in the structural shop here, to Scott Co., 243 Minna St., San Francisco, at $41,380.

Ont., Ottawa—The Dept. Pub. Wks. has awarded the contract for additions to boiler room at the Printing Bureau to G. C. Graves Co., at $77,000.